Manual for
Turfgrass Maintenance
with Reduced Environmental Impacts

Prepared by the Seacoast Stormwater Coalition

Funded by the New Hampshire Coastal Program through the Federal National Oceanic and Atmospheric Administration Office of Ocean and Coastal Resource Management Pursuant to the Coastal Zone Management Act of 1972

November 2012 Draft

Acknowledgments

This Manual was adapted for New Hampshire from the Minnesota *Manual for Turfgrass Maintenance with Reduced Environmental Impacts,* developed by the Minnesota Watershed Management Organization and Fortin Consulting. This manual was part of a project by the Seacoast Stormwater Coalition, a regional group of municipalities working together to reduce stormwater impacts in N.H.'s coastal watershed. It is dedicated to the towns and cities of New Hampshire who want healthy turf on their playing fields and landscapes, while protecting the quality and appearance of our water bodies. If you are involved in turfgrass maintenance, you have an important role to play in protecting our natural resources.

This manual is not to be used in place of other required training offered by organizations or municipalities. Content was created and reviewed through collaboration with local experts. Turf maintenance recommendations are based on current science; these are evolving, and updated revisions will be provided. Visit http://des.nh.gov/organization/divisions/water/stormwater/bmps-green-spaces.htm for updates.

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Table of Contents

PURPOSE OF THIS MANUAL

The purpose of this manual is to explain and illustrate how to reduce the environmental impacts from turfgrass maintenance without reducing the level of service. The information focuses on maintaining healthy turf while reducing impacts to water quality from excess nutrients. This manual is not designed to take the place of any specific courses available by organizations, and can be utilized by municipalities, organizations, businesses and individuals at the home level.

This manual will help you make better, more proactive, cost-effective choices in turfgrass maintenance. Focusing on healthy turf science, it will give you knowledge to become a leader in the turfgrass industry by operating more efficiently and being more environmentally conscious. There is no single maintenance approach that will fulfill all of the various uses for turfgrass; different strategies are needed for different conditions and different outcomes. In the spring and summer of 2012, this manual was piloted by the communities of Greenland, Portsmouth, Rye and Seabrook. We encourage you to continue to test, document, and refine the practices from this manual; the manual will be continuously adapted and improved upon based on stakeholder feedback.

This manual was developed by Seacoast turf practitioners with a focus on reducing nitrogen pollution from fertilizer. Nitrogen is the pollutant of concern in salt water and estuarine environments, while phosphorus is the pollutant of concern in freshwater environments. Though focused on protecting coastal environments, the tips will also be useful for turf managers in other areas of the state.

DISCLAIMER: The content of this manual includes emerging research; future updates are likely. For the most current version of the manual, or to provide updated information, please contact the Coastal Program, or visit: http://tinyurl.com/cleanwateronefieldatatime.

Throughout the manual you will find this fish symbol. The fish indicates a tip that will help you reduce environmental impacts.

You will also find cost-saving tips highlighted with a dollar symbol.

Plant health tips are noted with this plant symbol.

For a summation list of tips, see Appendix B.

INTRODUCTION

Good Business Choices

Those involved in turfgrass maintenance face many challenges; quality and customer service are the key to success. The public wants knowledgeable, accurate service, and providing a well-planned and executed turfgrass maintenance program will make a positive impression. This guide will provide you with up-to-date information on best practices for turfgrass maintenance.

$ ***Save time and money: Use the right amount of material at the right time, and use less material in the long run.***

$ ***Expertise in turfgrass maintenance is a good reflection on you and your town or organization.***

Turfgrass areas are essential to our way of life in New Hampshire. The public wants safe, aestheticallly pleasing, and well-groomed green areas to view, sit on, and play and walk in. By understanding the materials you use, optimal application times and rates, and by using reduced or non-chemical ways to enhance your turfgrass, you can have nice looking, functional turfgrass as well as satisfied patrons.

The public and your customers want affordable turfgrass maintenance. By following better maintenance practices, you can reduce the time needed to maintain each property, the frequency of maintenance, the amount of chemical used to maintain healthy turfgrass, and the associated costs.

The public and your customers want to protect our lakes and rivers – they want environmentally responsible maintenance professionals. Understanding the potential impacts of your work and adopting best magement practices will help you become more environmentally responsible. With your new knowledge, you can also educate the public and your customers on the importance of responsible turfgrass maintenance.

 ***To protect our surface waters, use less chemicals, prevent erosion, and sweep up grass clippings and other vegetative debris from sidewalks, driveways, and other hard surfaces.***

 ***Do not direct the discharge of clippings from side delivery mowers onto the street. These can directly pollute surface waters when they flow into storm drains with surface runoff.***

How Turf Management Impacts New Hampshire Waters

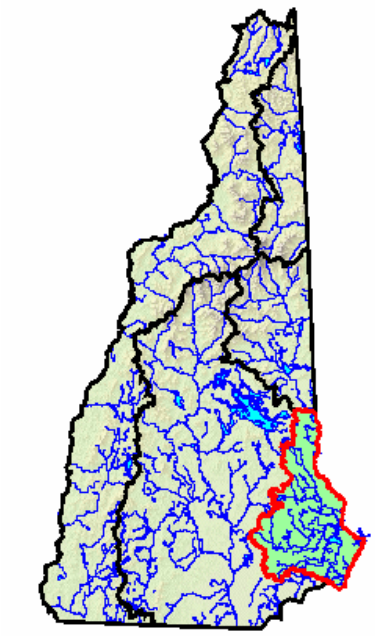
From the White Mountains to the coast, New Hampshire's residents love the outdoors, even when it is just our backyard; however, the way we maintain our lawns, parks, and public spaces can affect the natural world in surprising ways. You probably know that pesticides and fertilizers are powerful chemicals that can hurt wildlife and pollute water if overused. But, did you know that simple maintenance activities such as mowing and watering can also have a large impact on our estuaries (places where freshwater and saltwater mix), lakes, rivers, even drinking water? Our actions on the land affect water quality and water quantity.

Turfgrass is the largest irrigated crop in the United States, covering about 49,000 square miles (Lindsey, 2005). Turfgrass surrounds us; we have installed it like outdoor carpeting throughout the state, at both the municipal and homeowner level. However, unlike other grasses, turfgrass is not native to New Hampshire, so it requires care to keep it healthy and attractive (Seedland, 2012). When we use sound, research-based information to determine how much fertilizer, pesticides, and water the turfgrass needs to remain healthy, we can reduce pollution in our estuaries and groundwater and save precious resources.

It may not always be visible when we use too much water or fertilizer on our lawns or playing fields; however, by the time we see the harm done to our local waters, it is often difficult and expensive to correct. When we do not understand the connection between our maintenance practices on the land and the quality of our water, improper maintenance can continue for many years, polluting the Great Bay and Hampton-Seabrook Estuaries, and other water bodies that New Hampshire's residents (and frequent tourists) love. Everyone likes green lawns, not green water!

Understanding watersheds

A watershed is the land area that drains to a specific surface water body, such as a lake, bay or river. New Hampshire is divided into five major watersheds: Coastal, Merrimack, Connecticut, Androscoggin, and Pemigewasset watersheds. These larger areas can be divided into smaller watersheds, which can be subdivided even further, until you reach a neighborhood scale.



Piscataqua River/Coastal Watershed

Figure 1 Piscataqua Region Estuaries Partnership, 2008

Watersheds act like giant funnels. Any rainwater that lands within the watershed washes pollutants off the ground and carries them through storm drainage systems, ditches, and streams to a lake, bay or river. Wherever you maintain turfgrass, you may impact surface water. For example, if fertilizer spills on a hard surface and is not cleaned up, rain will eventually wash it into a lake, stream, or wetland. If it is on our streets today, it is in our waters tomorrow.

Impacts to our surface waters from turfgrass maintenance are more likely in developed areas where storm drains (stormwater pipes) carry water and pollutants directly to nearby surface waters. Every time it rains, water washes down

rooftops, driveways, streets, lawns and landscapes, carrying grass clippings, fertilizer, and eroded soil into storm drains. Stormwater pipes then carry the polluted water, untreated, directly to a local estuary, lake, or river. Our storm water pipes do not drain to a wastewater treatment plant. In some cases the polluted water is routed to a stormwater treatment pond, which can remove some pollutants, but most of the pollution ends up in the places we fish, swim, and play.

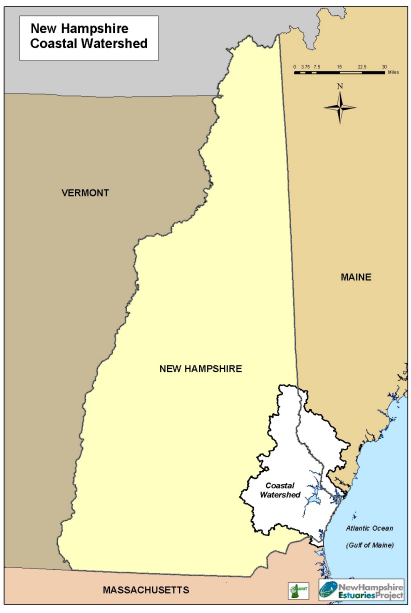
Status of New Hampshire's Coastal Waters

New Hampshire's coastal water resources are highly sensitive and are subject to intense and increasing pressures associated with population growth and development. These pressures include increased pollution from nonpoint or diffuse sources such as stormwater runoff, septic systems, lawn fertilizers, and agriculture, as well as point sources such as wastewater treatment facilities. Additionally, increased intensity and quantity of rain combined with human activities has increased pollutant loads into the watersheds' surface and ground waters.

Wherever you are in the 42 New Hampshire coastal watershed communities, your activities impact the water quality in the Great Bay and Hampton-Seabrook Estuaries.

Coastal Wetlands

Beyond the natural beauty they ensue, coastal wetlands play a major part in habitat restoration. These wetlands filter waters that drain into the ocean, and can help mitigate impacts from development and extreme weather in coastal communities. Additionally, coastal wetlands can be places of importance to local fishing and recreation. With development, environmental hazards, and sea level rise, these wetlands are disappearing very quickly. Keeping these waters clean and protected is important to not only the welfare of the wildlife that need them to survive, but also to the seacoast communities.



Great Bay

New Hampshire is home to the Great Bay, a "hidden coast." The Great Bay is unique because it is both a saltwater and freshwater system (better known as an estuary), set apart from the coastline. Great Bay provides food and shelter for a diversity of animals and plants that serve as building blocks for the ocean environment. Water levels in the bay are heavily influenced by daily tides, which expose mudflats at low tide, providing important feeding grounds for birds. In recognition of Great Bay's beauty, diversity and productivity, the U.S. Environmental Protection Agency designated it as one of only 28 "estuaries of national significance".

A large area – more than 1,000 square miles – drains into the bay. The water flowing from 42 New Hampshire and 10 Maine communities ends its journey in this estuary. Seven rivers carry water from these

communities into Great Bay, including excess nitrogen from fertilizer and other sources. Sadly, the Great Bay estuary is showing signs of a failing ecosystem from this and other water pollution. The 2009 State of the Estuaries Report, published by the Piscataqua Region Estuaries Partnership, showed 11 of 12 environmental indicators with negative or cautionary trends – up from seven in 2006. Low oxygen levels and eelgrass loss as well as increased "green stuff", or microalgae blooms, have all been documented in Great Bay.

Rising nitrogen levels in Great Bay increasingly concern scientists and community members. When large quantities of nitrogen are introduced into a body of water, algae begin to grow and reproduce rapidly, covering the surface of the water and occupying the upper layers of the water column, both blocking sunlight and consuming vast amounts of oxygen, effectively suffocating many of the organisms beneath. In a place where everything is connected, the threat extends from eelgrass to fish, birds, and other life that rely on this habitat for food and refuge.

Hampton-Seabrook Estuary

Unlike the Great Bay Estuary, the Hampton-Seabrook Estuary is dominated by salt marsh habitat. In addition, the estuary supports important coastal habitats including the most productive soft-shell clam beds in the state and important feeding and nesting grounds for shorebirds, as well as remnant sand dunes that help protect the coast from storms. This watershed is not meeting water quality standards for bacteria, causing frequent closings of shellfish beds.

The Hampton-Seabrook Estuary watershed encompasses 47 square miles and includes seven New Hampshire communities and one Massachusetts community.

NUTRIENTS AND TURFGRASS

Three main nutrients are used on turfgrass: nitrogen, phosphorus, and potassium. When applied according to soil test recommendations, we can reduce the amount of nutrients that could potentially drain from turfgrass areas into streets and streams.

Nutrients

Turfgrass requires nutrients to perform everyday functions, such as growing strong shoots and roots, fighting disease, and competing against weeds. All plant nutrients except for carbon (C), hydrogen (H) and oxygen (O) are supplied by the soil. Occasionally, the soil nutrients must be supplemented or the turfgrass plant will struggle.

Nitrogen (N), Phosphorus (P), and Potassium/Potash (K) are essential for turfgrass nutrition. There is a benefit in providing nutrients to turfgrass in the proper amounts. Excess nutrients can leave soils and cause water quality problems in Great Bay and our lakes, rivers, and ground water. In most cases, except nitrogen*, conducting soil tests and following test recommendations allow us to apply the proper amount of nutrients. Learn about soil testing on page 24.

Nitrogen (N), phosphorus (P) as phosphate (P_2O_5), and potassium (K) as (K_2O) are the three main nutrients displayed on the fertilizer bag. The percent, by weight, of these nutrients in the bag are always displayed in this order, (N-P-K).

*"Soil nitrogen can be measured accurately, however, a routine standard soil test for nitrogen and resultant fertilizer recommendation for lawns is problematic since there are no calibration data that relate to some measures of soil nitrogen to lawn responses. Consequently, nitrogen recommendations for lawns have been based on set rates and dates, regardless of actual needs." (Guillard, University of Connecticut, 2008)

According to the Shoreline Water Quality Protection Act, no fertilizer, except limestone, can be used within 25 feet of the reference line. Beyond 25 feet, slow or controlled release fertilizer may be used. Always check with local town ordinances as several towns have restrictions that are more stringent than the SWQPA.

Nitrogen (N)

Nitrogen is the component in fertilizer that stimulates growth and greens up your turfgrass. It aids in shoot and root growth and in turfgrass recovery from wear and tear.

- Nitrogen is the first nutrient listed on any fertilizer bag.
- Turfgrass can only absorb a limited amount of nitrogen.
- Similar to phosphorus (see below), plants only take up what nitrogen they need – the rest is left in the soil. Nitrogen is necessary in soil, but an excess can degrade the ecosystem and can eventually leach through to groundwater and surface water wetlands, all of which will affect water quality in estuaries, lakes, and rivers.

- Nitrogen is one of the problem pollutants (also known as the "limiting factor") in salt water systems, including estuaries. Too much nitrogen present in a salt water system creates a situation where habitat degradation and diversity loss can occur; this can lead to plants and animals being "starved" of other important nutrients, namely oxygen.
- Leaching or runoff of unused nitrogen can harm water resources.
  - Groundwater contamination: Nitrogen can leach (wash out of soils) into the groundwater. High nitrogen levels are associated with Methemoglobinemia or "Blue Baby" syndrome, a potentially fatal condition in which the blood cannot carry enough oxygen. Infants under 6 months old are most susceptible.
  - Surface water contamination: The Bellamy River, Exeter/Squamscott River, Lamprey River, Oyster River, Cocheco River, Piscataqua River, Salmon Falls River, and Winnicut River are the major rivers in the New Hampshire coastal watershed. All meander through towns and cities, picking up nitrogen (and phosphorus) runoff from impervious surfaces, farms, and surface wetlands, before entering into our estuaries. Excess nitrogen can harm water quality for human consumption, and freshwater and saltwater species.
- The United States Environmental Protection Agency (EPA) has a drinking water standard for nitrogen of 10 mg/L (parts per million).

Slow- Release vs. Quick-Release Nitrogen

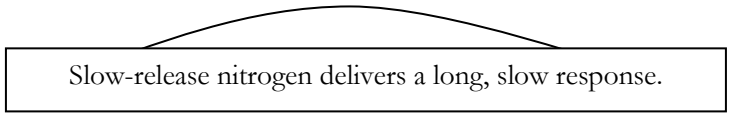
All turfgrass fertilizers contain nitrogen, which is available in either quick-release or slow-release forms. The Best Practices Matrix often recommends 35-50% slow-release nitrogen, which can be safer for the environment when applied properly. It is less work to apply over the course of the season, but may be more difficult to find and more expensive, and may not be appropriate when you need new turf to grow quickly.

How to determine if your fertilizer contains slow or quick-release nitrogen
Nitrogen is listed in a variety of ways, and it can be confusing. Below is a list of common nitrogen sources based on their release characteristics.

Slow-Release Nitrogen	**Quick-Release Nitrogen**
Releases slowly over time	Releases immediately
Water insoluble	Water soluble
Safer for water resources	May have more impact on water resources
More even and prolonged release of nutrient to turfgrass	One time short burst of nutrients for the turfgrass (can result in too much N available too quickly)
Expensive	Inexpensive
May be more difficult to find (retail)	Easy to find
Not good when quick growth is needed	Can be more appropriate when starting turf

<u>Sources of Slow-Release Nitrogen</u>:
Water Insoluble Nitrogen (WIN)
*Organic/Natural** –

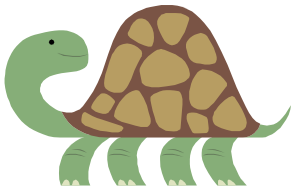
- Activated sewage sludge
- Animal manures
- Corn gluten meal



- Other natural products such as blood meal, bone meal, soy meal, feather meal, fish meal and some composts.

Synthetic –

- Stabilized nitrogen (look for "stabilized" listed on bag)
- Sulfur-coated urea
- Polymer-coated urea
- Polymer-coated sulfur-coated urea (PCSCU)
- Isobutylidene diurea (IBDU)
- Methylene ureas
- Ureaformaldehyde (Ureaform)



<u>Sources of Quick-Release Nitrogen</u>:

These are most common sources of nitrogen, and what is usually in the fertilizer bag.

Synthetic Organic –

- Urea $CO(NH_2)_2$

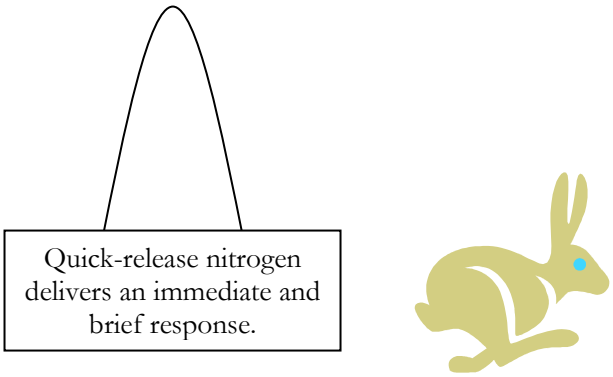
Synthetic Inorganic –

Ammoniacal Forms

- Ammonium Nitrate (NH_4NO_3)
- Ammonium Sulfate $(NH_4)_2SO_4$
- Monoammonium phosphate $NH_4H_2PO_4$
- Diammonium phosphate $(NH_4)_2HPO_4$

Nitrate Forms

- Ammonium nitrate (NH_4NO_3)
- Potassium Nitrate KNO_3



*Note: many natural sources also contain phosphorus

Nitrogen is often used to bring a greener color to turfgrass, but it can damage the environment when: used at the wrong time of year, in excess amounts, or before a big rain or accidental watering.

To protect the environment and get the most out of your fertilizer, use slow-release nitrogen fertilizer.

Nitrogen is more of a problem pollutant for saltwater, while phosphorus is more of a problem pollutant for freshwater; however, excessive amounts of both can lead to problems in both salt- and freshwater systems.

Phosphorus (P)

Phosphorus is naturally found in soil, and is essential for plant life. It aids root development, leaf growth, and shoot growth, all of which improve turfgrass density and reduce runoff. New Hampshire soils are rich in phosphorus, so small amounts of phosphorus runoff can severely impact the water quality of our rivers, lakes, and coastline. One pound of phosphorus can fertilize the growth of up to 500 pounds of algae (Struss, 2003).

Phosphorus tightly binds to very tiny soil particles, and can move quickly during times of intense precipitation and snowmelt. Under certain conditions, phosphorus can be lost from the turfgrass area, primarily through runoff and on rare occasions through leaching. Some of those conditions include:

- Excessive applications
- Application on frozen soils
- Application on high-phosphorus soils
- Misapplications to hard surfaces
- Erosion from thin grass/bare soil areas

Phosphorus is a major source of pollution in lakes and rivers

Phosphorus is one of the problem pollutants (or "limiting factor") in freshwater systems. Excess phosphorus increases production of algae and stimulating growth of aquatic vegetation, leading to our lakes and rivers turning green. This spoils the lake view and harms aquatic life. As aquatic vegetation dies and biodegrades, oxygen needed by fish and other small aquatic life may be depleted. Nuisance algal blooms and excessive aquatic plant growth can also limit swimming, fishing, and boating. Turfgrass maintenance is one of many sources of phosphorus.

Causes of phosphorus pollution related to turfgrass maintenance:

Over-applying phosphorus fertilizer

Like any natural nutrient, plants will not absorb more phosphorus than they can use. Excess phosphorus that is applied to turfgrass can potentially run off the land and into the water. Research has shown that the largest amounts of runoff and phosphorus loss from a lawn occur when the ground is frozen. To minimize P runoff, apply on actively growing turfgrass and apply only what is needed based on a current soil test (not more than 3 years old).

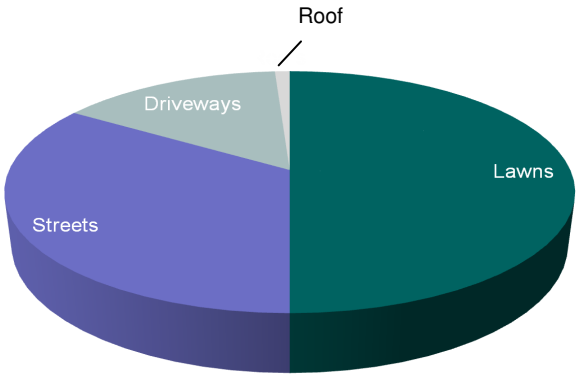
Spilling phosphorus fertilizer onto hard surfaces

As mentioned earlier, the Shoreline Water Quality Protection Act (SWQPA) stipulates that no fertilizer is permitted within 25 feet of the shoreline. The protected shoreline is 250 feet, and while fertilization is permitted beyond the 25 feet buffer of the SWQPA, spillage of excess fertilizer (both containing and not containing phosphorus) should be swept up immediately. When applying along sidewalks and other narrow areas, using a deflector or drop spreader will help prevent misapplication.

Grass clippings, leaves, and tree seeds on hard surfaces

All vegetation contains phosphorus (and nitrogen). If left on hard surfaces, it will wash into storm drains and into the lakes and rivers. As plant material breaks down and decomposes, nutrients can be released and potentially become available to algae and other plants. A few grass clippings in the street may appear harmless, but collectively they can increase the nutrient levels in our lakes resulting in more severe and frequent nuisance algal blooms.

Soil erosion
Exposed and unprotected soil has great potential to wash offsite when it rains. These tiny soil particles with phosphorus and potentially other contaminants attached are carried in stormwater to the storm drain and piped into lakes and streams. Neglected turfgrass is more prone to erosion than well-managed turfgrass.



Sources of Phosphorus runoff in urban areas.
Data: Three Rivers Park District

How to minimize phosphorus release into surface waters

Without a soil test:

- Use 0% phosphorus lawn fertilizers.

Where soil tests recommend phosphorus, or in starting new turfgrass areas:

- Calibrate equipment so that you are applying the proper amount.
- Follow soil test recommendations. Do not over-apply fertilizer.
- Immediately sweep up fertilizer that is misapplied onto hard surfaces.
- Gently water in the fertilizer. Do not over water.

Potential Signs of phosphorus deficiency

- Slower, less vigorous growth
- Pale color in extreme deficiency
- More prone to weed invasion due to less competitive growth
- Purplish color on plant stem in the spring/early summer

Most New Hampshire soils are rich in phosphorus and do not require additional phosphorus applications to adequately support an established turfgrass stand. Always use a soil test to be sure – don't guess!

New Hampshire law stipulates a 25' fertilizer-free buffer around all water bodies. Outside this 25' buffer, fertilization is allowed, but make a point to sweep up excess fertilizer that is spilled or otherwise left on hard surfaces within 250'.

Potassium (K)

Although it is generally immobile in soils and is not considered an environmental concern, potassium is essential for plant growth and survival. It aids a plant's tolerance to stress, such as cold/hot temperatures, drought, wear, and pest problems. In larger areas, potassium is less likely to be affected, and can withstand both droughts and long winters.

Turfgrass color or density will not be affected unless the grass is truly deficient in potassium. Adequate potassium levels are important for the efficient use of nitrogen by the grass plant. There is usually enough potassium in the soil without needing to add any by fertilizing, but a soil test could determine if the

potassium level in your soil is low; your best method for determining soil potassium levels is a soil test. Once potassium deficiency occurs, a plant will struggle to survive and function during times of stress.

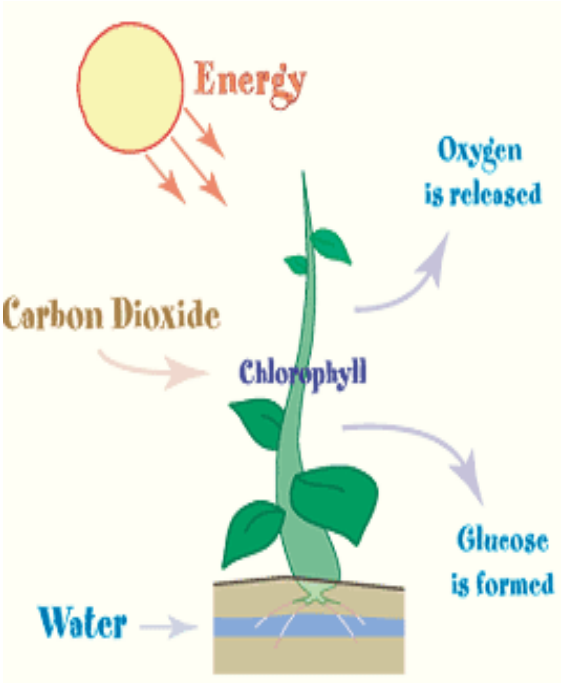
Turfgrass Health

By understanding a bit of the science behind turfgrass growth, we can be more efficient in producing and maintaining healthy stands of turfgrass. As we base our decisions on this science, we will save money, save time, and protect the environment.

Photosynthesis
Plants require sunlight, carbon dioxide and water to grow. That is why many plants, including many of our turfgrass species, do not thrive in the shade (lack of sunlight), or in very hot, dry places (lack of water) such as parking lot islands.

Use photosynthesis to your advantage:

- The larger the plant, the greater its photosynthesis capability, i.e. free plant energy!
    - It is always to your advantage to mow typical lawn grasses such as Kentucky bluegrass, perennial ryegrass, and the fine fescues, at a higher setting (see "Mowing" in the "Lawn Care and Maintenance" section – page 45).
- Provide proper amount of water (see "Irrigation" in the "Fertilizer, Herbicides, and Irrigation" section – page 34).
    - Enough water prevents wilt and allows photosynthesis to continue.
    - Too much water results in "drowning" roots, which inhibits water uptake into the plant creating a "water deficit". That can create a wilted condition, which in turn results in reduced intake of carbon dioxide and therefore reduced photosynthesis, resulting in less food for plant growth and survival. More importantly, excess irrigation wastes our drinking water.
- Select seed appropriate to sunlight conditions. Some turfgrass plants are able to be successful with less sunlight (see "Seeding" in the "Lawn Care and Maintenance" section – page 43).
- Maximize sunlight in shady areas by trimming trees.



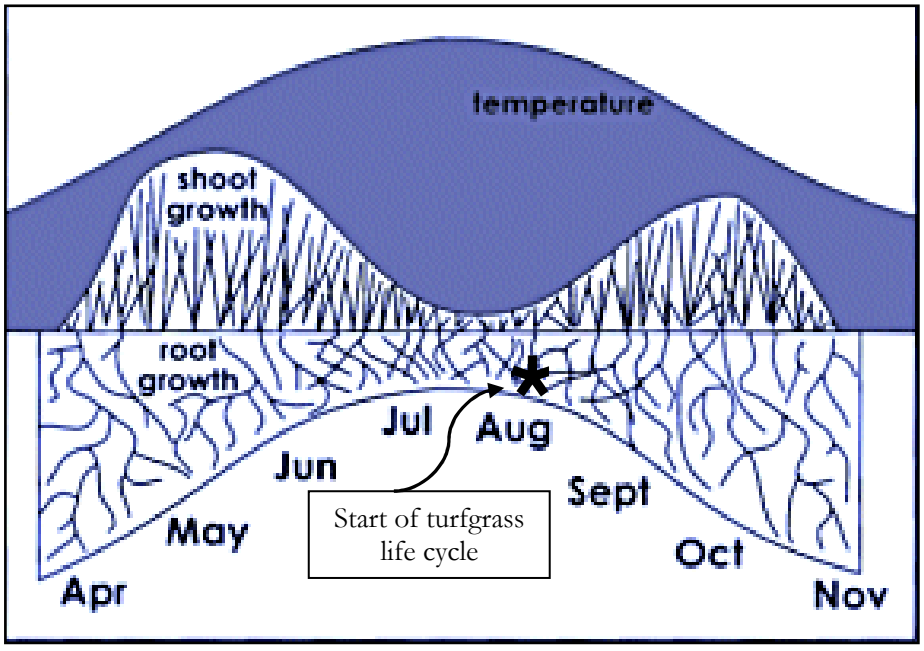
Graphic Source: Saviodsilva, n.d.

Life cycle of Turfgrass

Individual grass shoots do not really begin their life cycle in the spring when New Hampshire greens up. In fact, the life cycle of grass begins around the end of July and early August. As the shoot actively grows through the fall, it reaches a stage of maturity that will result in its sending up a flower stem the following spring. After lying dormant and inactive during the winter months it begins a rapid period of growth in the spring with its primary emphasis on producing that flower stem. We often do not see much of the flowering as we are continually mowing and removing most, if not all, of those flower stems. Nonetheless, once that shoot has flowered, it dies and turns brown. Visually, this leaves our lawn looking somewhat thinner than normal come the end of June or early July. Thankfully, not all shoots in a lawn flower in the same year. Those remaining begin the growth cycle all over again come late July and early August.

The practice of caring for turfgrass should be based on the science of turfgrass growth and development. The diagram below is a lifecycle diagram of the turfgrass shoot. The fall portion of the lifecycle is very important, as that is the time when new shoots are produced (marked with an asterisk *) as well as other vegetative growth structures (i.e., rhizomes, tillers, stolons). This is also a time for vigorous root production, which helps support active shoot growth by absorbing water and nutrients necessary to sustain that growth. Later in the fall, root absorption continues, but the top growth slows down due to shorter days and cooler temperatures. At this time food from photosynthesis is involved with nutrient storage and other needed plant products until active growth reinitiates the following spring (see the Best Practices Matrix).

Cool Season Grasses



Adapted from graphic source: University of Minnesota, 2006

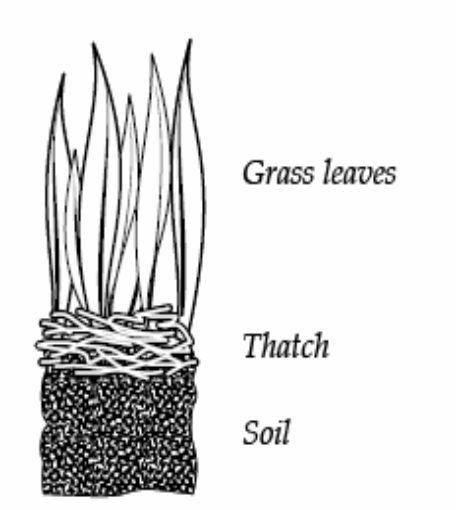
Healthy, vigorous plants depend on large, healthy root systems. Deeper, more robust root systems provide better access to nutrients and water and improve the chances of surviving a drought. Irrigation has a big influence on root depth. Frequent, shallow waterings encourage shorter root growth and can create excessively wet surface soil that, in turn, can lead to a variety of serious turfgrass diseases and increased stress. Infrequent deep waterings encourage deeper root growth, particularly during spring and fall. This will still keep the turfgrass green and actively growing without creating excessively wet conditions. It is also important to not apply more water than can seep into the soil at any one watering. In general, it is wiser to practice infrequent, deeper waterings, rather than frequent, shallow waterings. For more information, see "Irrigation" in the Fertilizer, Herbicides, and Irrigation section – page 34.

Example Cool Season Grasses:

- Kentucky bluegrass
- Perennial ryegrass
- Fine fescue
- Colonial Bentgrass (not common)

As turfgrass grows and the blade is cut, the clipping falls to the soil surface where it provides a light "mulch" cover, providing much desired shade for the hot summer soils and, as it decomposes, provides nutrients. Clippings do not cause thatch. Clippings decompose rather quickly and do not become incorporated into the thatch layer.

Thatch is a dark brown, felt-like layer just above the soil. It is normal and necessary. It is composed of both living and non-living plant parts, and is primarily a product of the continuing cycles of dying and replacement of shoots and roots. Thatch is not all bad. It protects the soil from temperature changes, helps retain moisture, and gives the turfgrass some resiliency against wear and tear. Thatch is rarely a problem; however, where thatch accumulates beyond ½ to ¾ of an inch, it is considered undesirable (for more on Thatch, see page 42).



Fagerness, 2001

Since turfgrasses (especially when used in a lawn) are not native to New Hampshire, they require our time and attention to maintain and care for them. Everyone has different expectations for their turfgrass. The Best Practices Matrix in this manual explains the basic care needed for minimal, average, and high quality turfgrass areas. These recommendations are based on turfgrass biology. The Best Practices Matrix recommendations should be followed as general guidance to reduce environmental impacts yet grow healthy turfgrass to meet expectations for its use and beauty.

To get more precise information on nutrient needs for your site, including pH, a soil test should be conducted and the soil-test recommendations followed. This will give custom guidance to your particular site, matching the soil chemistry with your turfgrass growth and development needs. This allows for top performance and minimizes environmental problems associated with incorrect application of fertilizers.

The University of New Hampshire Cooperative Extension has information on how to conduct a soil sample and how to send that sample (and other pertinent information, which is documented on a form sent in with the sample) to the UNH Cooperative Extension office. For more information on soil tests please see page 24 of this manual, or visit http://extension.unh.edu/.

Infrequent, deeper waterings encourage deeper root growth, which is ideal during wetter months and when grass is new.

Basic Identification of Common Turfgrasses

Kentucky Bluegrass

- Medium to dark green color often slightly bluish green
- Upper leaf surface dull, flat green while lower leaf surface is slightly more glossy
- Medium blade width, leaf folded or creased in half
- Leaf tip shaped like the front end of a canoe or boat
- Not bunchy in growth habit
- Best adapted to sunnier conditions, spreads by vigorous rhizome growth

Rye grass

- Medium to dark green in color
- Upper leaf surface dull green while lower surface is a very shiny, glossy green – distinctly more so than either fine fescues or Kentucky bluegrass
- Medium blade width, prominent mid-vein down middle of leaf
- Leaf tip more pointed – not distinctly boat shaped as in Kentucky bluegrass or needle-like as in fine fescue
- Tufted growth habit – no rhizome production
- Best adapted to sunnier conditions
- Extremely susceptible to crown rust under low nitrogen fertility conditions

Fine Fescues

- Medium green
- Very narrow wiry blade
- Very narrow wiry blade, leaf folded or creased in half – opens slightly as it matures
- Leaf tip comes to a needle-like point
- Grows in tufts or slowly expanding patches
- Best shade tolerance of the three major turfgrasses thus often found in the shady areas

Colonial Bentgrass

- Fine-textured cool-season grass
- Can be cut at extremely short heights (1/2" or less)
- Extremely high maintenance and high disease potential
- Often considered a weed, commonly found on golf courses
  (Outside Pride, 2012)

Know your turf grasses! Understanding which grasses grow best in certain conditions will allow for your turfgrass to remain healthy and is, therefore, better for the environment and water quality.

SITE CONDITIONS, EXPECTATIONS, AND MAINTENANCE

Setting and Managing Expectations

There are many different criteria for managing turfgrass areas and many preferences for turfgrass appearance. The key to successful management is to understand the conditions and use of the site and to set realistic expectations. The choices given in the Best Practices Matrix are minimal, average, and high turfgrass quality. Neither neglected nor perfect turfgrass is an ecologically sound choice, and neither is offered as an option in the Best Practices Matrix.

Performing site assessments will help you understand existing conditions and select an appropriate turfgrass quality level for each site you manage.

Site Assessment

One of the best things you can do to make informed decisions for managing a site is to assess and record its condition. Whether you maintain a city park or a private residence, each property has its own issues. This simple routine will help you make wise, informed decisions that benefit the turfgrass, protect the waters, and please the public and your customers.

How often to assess?
All new sites should have a thorough site assessment. Shorter assessments can be conducted periodically as you visit the sites. These mini assessments may include notes and photographs to document weeds in their blooming stage, erosion, irrigation patterns, traffic/use, and other clues that can help you improve your maintenance plan.

How to create a site assessment form

You can use the Example Site Assessment form at the end of this section, visit the UNH Cooperative Extension website (mentioned above) to use their form, or create your own and include whatever information is necessary for your property. Print out a stack of these forms, place them on a clipboard and have them available for use at anytime.

Gear to bring on a site assessment:

- Camera
- Clipboard
- Pencil
- Site assessment form
- Soil test kit (hand shovel, small bucket, soil sample form, new re-sealable zipper storage bag, waterproof marker, pen)
- Soil probe

Optional Gear:

- Sample bags/labels (for unknown plants)
- Tape measure/measuring wheel

- Flagging/flags
- GPS

How to conduct a site assessment

- Name or number each site
- Put name or number on top of site assessment form
- Fill out site assessment form for each site
- Soil test (every 3 years)

Following your assessment, take time to analyze observations, create and communicate maintenance recommendations, follow your own recommendations, and continue to assess the site over the lifetime of your maintenance operations.

A site assessment will:

- *Sharpen your observation skills.*
    - Site assessments train you to look for valuable clues about the overall health of the turfgrass. They will also guide you in judging if the site expectation is sustainable.
- *Help inform everyone on your crew.*
    - Documentation on the site's history, maintenance efforts, successes and failures, and current plan of action will improve transitions between personnel.
- *Help manage each site more effectively.*
    - Maintenance recommendations based on specific site conditions and turfgrass expectations will be more effective than those based on a one-plan-fits-all strategy. Problems can be identified and addressed before they become large concerns.
- *Help track the success of maintenance practices.*
    - You can improve faster if you record and track your operations and their results. Did the herbicide treatment work? Did it harm anything else? How much herbicide was saved by calibrating equipment? Is the taller mowing height benefiting the health and thickness of the turfgrass? Keeping track of these observations in a record is important in the long run.

Note any ongoing site observations should be recorded and maintenance efforts modified to match conditions, for example:

- A tree was removed, and now there is a sink hole.
- The irrigation system is spraying the sidewalk.
- Deer are damaging the new trees.
- A patch of dead grass has suddenly appeared where we filled the fertilizer spreader.

Best Practices Matrix

The Best Practices Matrix offers ecologically sound advice without compromising turfgrass quality expectations. It is a compressed summary of maintenance recommendations and can be printed out and brought into the field for easy access.

Using the Best Practices Matrix

The Best Practices Matrix offers practical guidelines based on your turfgrass quality expectations (minimal, average, high). It offers straightforward advice for cultural practices, fertilizing, and other typical turfgrass maintenance activities. It is divided into six sections, each with custom recommendations based on soil type and sun exposure. To use the Best Practices Matrix in the field, visit http://www.pca.state.mn.us/index.php/view-document.html?gid=12941.

FieldScout Turf Color Meter

Oftentimes people over-fertilize and over-water their turfgrass simply based on the color, or brightness. Hues of color are often misconstrued due to cloud cover, angle of the sun, and reflectivity of the kind of grass in an area. The New Hampshire Seacoast Stormwater Coalition has acquired several FieldScout Turf Color Meters to measure the exact color of the grass being analyzed, allowing more accurate and appropriate maintenance to occur on a particular area of turfgrass.

The Turf Color Meter measures reflected light from a small square of grass in the red and near-infrared light spectrums, which negates the effect of sun and cloud conditions. The meter allows for readings to be taken in upright positions, and the data can be stored in the meter and later moved to a computer. This information can be used to create a topographic map of turfgrass conditions, to better utilize maintenance practices in the future.

The Turf Color Meter is not for everyone. Generally, larger commercial or municipal lawns are the most suitable for this equipment. The measurements given by the Turf Color Meter portray the average color of the turfgrass, but do not state what specific treatments are needed to improve the grass; additional information would be necessary, which is only acquired through a soil test. See Appendix C for a how-to for the Turf Color Meter.

To inquire about using a Turf Color Meter on your field(s), contact the New Hampshire Department of Environmental Services, Portsmouth Office at 603-559-1500. For more information on specs for the FieldScout Turf Color Meter, visit http://www.specmeters.com/brands/field-scout/tcm500/.

Site Assessment

Date: _____ Assessor: _____

Site name: _____

Address: _____

Age of turf _____ (years) Turf size _____ (sq.ft.)
Dogs: ☐ Yes ☐ No
Children: ☐ Yes ☐ No
Traffic Volume: ☐ Minimal ☐ Average ☐ High

Customer/Town Expectations & Maintenance Practices

Lawn Condition: ☐ Minimal ☐ Average ☐ High
Clippings bagged: ☐ Yes ☐ No
Organics only: ☐ Yes ☐ No
Fertilizer: ☐ Yes Ratio_____ ☐ No
Herbicides: ☐ Whole yard ☐ No ☐ Spot treat (add sketch)
Herbicide needed: ☐ Pre-emergent ☐ Broadleaf ☐ Non-selective ☐ None
Pesticides: ☐ Whole yard ☐ No ☐ Spot treat (add sketch)
Irrigation: ☐ Yes ☐ No
Calibrated: ☐ Yes, Date_____ ☐ No
Water reaching hard surfaces: ☐ Yes ☐ No
Rain sensor: ☐ Yes ☐ No
Operating properly: ☐ Yes ☐ No
Estimated water output: _____
Watering frequency: _____

Turf Condition

Turf Meter

Turf Meter average: _____ *Number of Readings (N):* _____

Take photographs. It may be helpful for next year to match a visual to a specific turf meter reading.

Grass

Major turf grass(es): ☐ Kentucky bluegrass ☐ ryegrass ☐ fine fescue

Condition of grass: ☐ blade damage ☐ good ☐_____

Thatch depth: _____" Rooting depth: _____"

Lawn density: ☐ thin ☐ average ☐ high

Soil sample(s) collected: ☐ Yes ☐ No
If Yes:

Soil texture: ☐ *Coarse (sand, loamy sand, sandy loam)*
☐ *Medium (loam, silt loam)* ☐ *Fine (clay loam, silty clay loam, silty clay and clay)*

Compaction test: ☐*not compacted* ☐ *somewhat compacted* ☐ *compacted*

Weed severity: ☐ many ☐ some ☐ few

Weed/Disease Types:_____
_____

Sun exposure (%): ☐ Full-sun_____
☐ Part-sun_____
☐ Shade _____

Other observations
Erosion problems_____
Intensity of Use_____
Wet Areas_____
Overall Topography_____

Sketch/Notes:

Recommendations (☐ add additional page):

Soil Testing

Why take a soil test

Conduct a soil test to determine what additional soil nutrients your turfgrass will need. This is the best information you can get to improve the performance of your maintenance operations. A soil test is valid for three years. It will:

- analyze the makeup and pH of your soil
- help you determine which formulation of fertilizer you should use
- help you calculate how much fertilizer you should apply
- tell you how frequently you should apply fertilizer
- allow use of phosphorus fertilizer if a need is shown
- save money by understanding your soils' needs

Many labs offer soil testing. For information on soil testing and to obtain a soil sample information sheet, visit the website listed in the University of New Hampshire, Cooperative Extension website at http://extension.unh.edu/Agric/AGPDTS/SoilTest.htm.

How to conduct a soil test

If you plan on sending your soil to be tested at UNH, here is some general soil taking information:

1. Using a clean plastic bucket and a spade (a garden trowel or soil probe would work as well), take soil randomly from at least 6-8 spots in each lawn or garden you want tested.
2. Combine the soil from these 6-8 spots to make one sample.
3. Air-dry the sample before sending it to UNH.
4. Remove stones and other large debris, and place ½ to 1 cup of dry soil in clean plastic bag (a Ziploc bag is best), labeled with a name and sample number.
5. Make sure you include the sample name(s) on the soil test form, and mail with your sample and check made payable to UNHCE.

To use the UNH Cooperative Extension for soil testing, use the form on the following two pages, which includes the "Commercial Turf" 2012 soil test form. To specialize your soil test form, visit http://ceadmin.unh.edu/soils/fees/soils_fees_home.cfm?review=14.

For other information on other soil tests available through UNH Cooperative Extension, visit http://extension.unh.edu/Agric/AGPDTS/SoilTestingForms.htm.

UNIVERSITY of NEW HAMPSHIRE
Cooperative Extension

Commercial Turf

2012 Soil Test Form

Client Information

Name	**Farm/Business Name**
Address	**County**
Town, State and Zip	**Phone**
Email	**Fax**

(Optional) Additional Copies to:

Copy Name	**Email Address**
Copy Address	**Town, State and Zip**
Phone	**Fax**

I prefer to receive test results by (Please select only one): ☐ Mail ☐ Fax ☐ Email

Please Note: In order to receive the soil report in the format noted above please make sure that the appropriate information (fax number, email address) has been included.

Sampling Directions

Take soil samples with care. If the sample is not representative of the area, the test results and lime and fertilizer recommendations will be of no value! Take samples from 15-20 locations per field, mix well, air dry, remove stones and other debris, and submit 1/2-1 cup of dry soil for testing. Sample to the following depths: Turf - 3". Name each sample and label each bag clearly (e.g. "Front Field", "Side Field", etc.)

Sample Summary

Number of Samples submitted:	**Total Cost $:**

Payment Type: ☐ Check ☐ Cash ☐ Account Please make checks payable to "UNH Cooperative Extension"

Contact Information

Mail or deliver samples to the UNH Cooperative Extension at the following address:

University of New Hampshire Cooperative Extension
38 Academic Way
G28 Spaulding Hall
Durham, New Hampshire 03824
603-862-3200
http://extension.unh.edu/Agric/AGPDTS/SoilTest.htm

Form Instructions. Please fill out the form as completely as possible. In order to differentiate your samples, all samples submitted must have a unique name.

Sample Name:

Reasons for Test: ☐ Routine ☐ Problem Diagnosis **Area:** ☐ < 1 Acre ☐ 5 - 10 Acres ☐ >10 Acres

Crop Codes

☐ Lawn/Park/Playground, seeding	☐ Lawn/Park/Playground, maintenance	☐ Athletic field, seeding
☐ Athletic field, maintenance	☐ Golf fairway, seeding	☐ Golf fairway, maintenance
☐ Golf green, seeding	☐ Golf green, maintenance	☐ Sod farm
☐ Other	Other type (please list):	

Soil Series or Type:

Tests (select the test(s) for the sample!)

☐ Field Soil Test (pH recommendation included) (T1 - $12)	**Total Sample Cost:**
☐ Organic Matter (T2 - $5)	
☐ Texture Class (T3 - $25)	
☐ Micronutrients (T4 - $6)	
☐ pH (pH recommendation only) (T6 - $6)	

Form Instructions. Please fill out the form as completely as possible. In order to differentiate your samples, all samples submitted must have a unique name.

Sample Name:

Reasons for Test: ☐ Routine ☐ Problem Diagnosis **Area:** ☐ < 1 Acre ☐ 5 - 10 Acres ☐ >10 Acres

Crop Codes

☐ Lawn/Park/Playground, seeding	☐ Lawn/Park/Playground, maintenance	☐ Athletic field, seeding
☐ Athletic field, maintenance	☐ Golf fairway, seeding	☐ Golf fairway, maintenance
☐ Golf green, seeding	☐ Golf green, maintenance	☐ Sod farm
☐ Other	Other type (please list):	

Soil Series or Type:

Tests (select the test(s) for the sample!)

☐ Field Soil Test (pH recommendation included) (T1 - $12)	**Total Sample Cost:**
☐ Organic Matter (T2 - $5)	
☐ Texture Class (T3 - $25)	
☐ Micronutrients (T4 - $6)	
☐ pH (pH recommendation only) (T6 - $6)	

UNIVERSITY of NEW HAMPSHIRE
Cooperative Extension

Education Center and Info Line
practical solutions to everyday questions
Toll free Info Line **1-877-398-4769**
M-F • 9 AM - 2 PM
W • 5 - 7:30 PM

Understanding Your Soil Test Results

What is a soil test?
The soil testing lab takes your soil sample, dries it, and runs a small portion of the sample through a series of sophisticated test equipment. The results provide a chemical inventory of the soil – clues as to the quantity of nutrients or elements in the soil and their availability for plant growth. The lab sends the results to UNH Cooperative Extension, where they interpret the numbers and provide you with specific lime and fertilizer recommendations for the plants or crops you intend to grow, based on our experience with New Hampshire soils and climate.

What information is on the report form?
The soil test results are sent to you by email or via the U.S. Postal Service on a computer-generated report form. Each report has a common format.

• **Lab ID:** Each sample is given a unique number. Please refer to this number if you have any questions.

• **Sample Name:** The name you gave to this soil sample. For example, *Front Lawn.*

• **Lab Run Date:** The date the lab analyzed your soil.

• **Staff Contact:** Please contact this person if you have questions about your sample or the recommendations. For help in determining the suitability of fertilizers and calculating application rates, you may also call the Education Center and Info Line Monday-Friday, 9am – 2pm at 877-EXT-GROW (877-398-4769).

• **Test Data:** The soil is tested for pH, and selected nutrients. Charts 1 and 2 offer additional information.

• **Recommendations:** Recommendations for lime and fertilizers, based upon the crop(s) you intend to grow.

Chart 1. Glossary of Terms on the Report Form

pH - Indicates whether the soil is acid or alkaline. 7.0 is a neutral level; less than 7.0 is acidic and greater than 7.0 is alkaline. Although NH soils are naturally very acidic (pH 4.5 – 5.5), most plants prefer a pH range of 6.0 – 6.5. Exceptions are acid loving plants such as blueberries, azaleas, rhododendrons, mountain laurel and holly, which prefer pH 4.5 – 5.5. Lime is most commonly used to raise soil pH levels.

Mehlich 3 - Name of the test techniques used to remove or extract the nutrients/elements from the soil sample.

ppm - Parts per million is the most commonly used term to describe the amount of each nutrient found in the soil. (Multiply this value by 2 to get approximate lbs per acre at a depth of 6 inches.)

Organic Matter - That portion of the soil made up of dead and decayed plant and animal parts. Organic matter provides nutrients for plant growth while improving the physical condition or tilth of the soil. NH soils often have 3-5% organic matter.

Ratings –

L – Low	O – Optimum
H – High	VH – Very High

Table 1: Plant nutrients found on the test results report.

Element	Function in Plant	ppm - parts per million			
Low		Optimum	High		Very High
Mg - Magnesium	Part of chlorophyll molecule necessary for photosynthesis	0 - 60	60 - 120	120 - 160	160+
Ca - Calcium	Calcium Important in cell elongation and cell division	0 - 800	800 - 1200	1200 - 2000	2000+
K - Potassium	Helps resist drought. Activates enzyme systems	0 - 170	170 - 280	280 - 430	430+
P - Phosphorus	Essential for energy transfer and fruit and seed formation	0 - 30	30 - 50	50 - 75	75+

**For more information on analyzing and interpreting soil tests from the University of New Hampshire Cooperative Extension, visit http://extension.unh.edu/Agric/AGPDTS/SoilTest.htm. **

How to read a soil test result

Soil tests help narrow down what may be missing for healthy turf. A soil test provides information on the soil pH, P, K, and other nutrients. Recommendations for lime and fertilizers for turf are then made based on these tests. Although N in the soil can be measured accurately, turf fertilizer recommendations for N are problematic since there are no calibration data that relate some measure of soil N to turf response. Consequently, N recommendations for turf based on soil tests are based on set rates and dates, not the actual need. (Guillard, University of Connecticut, 2008)

Note that a recommendation of 0.5 lbs of P or N per year per 1,000 square feet is not the same as 0.5 lbs of fertilizer per 1,000 square feet. A calculation must be done to figure out how many pounds of fertilizer from your bag are needed.

If the soil test indicates that P and/or K are adequate, use only N if available (e.g. urea, ammonium sulfate, corn gluten, etc).

If only N fertilizer is not available, choose a grade or brand with the lowest possible numbers for P and K, the second and third numbers on the fertilizer bag (N is *always* the first number on the bag). For example, corn gluten is typically listed as having a ratio of 9-0-0, meaning 9% Nitrogen, 0% Phosphorus, and 0% Potassium, by weight.

FERTILIZER, HERBICIDES, AND IRRIGATION

Fertilizers

How to choose the correct fertilizer

Use soil test results to choose the proper fertilizer.

1. Look at recommended ratio on soil test results: *Example: 15-0-30*
2. Select a fertilizer that most closely matches the nutrient ratio from your soil test. In this example, a 15-0-30 is a 1-0-2 ratio.
3. The Best Practices Matrix for your site will guide you on percentage of slow-release N.

What if that fertilizer ratio isn't available?

Use the closest ratio that you can find without exceeding N or P.

Example: Test recommendation is 15-0-30. If not available, settle for 10-0-30 or 12-0-25; the latter is still very close to a 1-0-2 ratio.

How to read the fertilizer bag:

Nitrogen-Phosphorus-Potassium/Potash (N-P-K)

Fertilizer bags list three important numbers. They are the percentage of the major nutrients (N-P-K) that make-up the fertilizer mixture. The example fertilizer bag reads 20-0-10. This means at least 20 percent of the contents of this bag is N, zero percent P, and at least 10 percent of the bag is K. The rest of the contents of this bag are inert materials that are used to help deliver the nutrients through your spreader.

Slow-release Nitrogen

Read the ingredients listed on the bag to find out if the nitrogen is slow-release or quick-release. This can be tricky. See the Nitrogen section (page 10), where there is a list of common names for slow-release nitrogen you can compare with the ingredients list on your bag.

Other Ingredients

The fertilizer bag will also list other ingredients that have been added to the mixture. However, it is filled primarily with inert ingredients that aid in the uniform dispersal of the material through a spreader.

Application Rate

The fertilizer bag will usually suggest various application rates and spreader settings for the fertilizer mix. Follow the soil test guidelines, not the fertilizer bag.

For the best growing results, follow the soil test guidelines, not the fertilizer bag guidelines.

You can save fertilizer by storing it over the winter in closed containers.

Who can apply fertilizer?

Anyone (i.e. business, individual, etc) who applies fertilizer for hire is required to have a fertilizer license administered by the New Hampshire Department of Agriculture, Markets & Food. Those that work for a municipality and apply to municipal property do not need a license. For more information, visit the NH Department of Agriculture website at http://www.nh.gov/agric/divisions/markets/index.htm.

When to apply fertilizer?

It is best to fertilize well after the ground is thawed in spring, and several weeks before the first deep freeze in the fall. Do not apply fertilizer before spring green up. Between late April and mid September is best. Avoid fertilizing in the mid-summer with cool-season grasses.

Never fertilize on frozen ground or before spring green up. It will green up our lakes, not our turfgrass.

How much fertilizer to apply based on the Best Practices Matrix

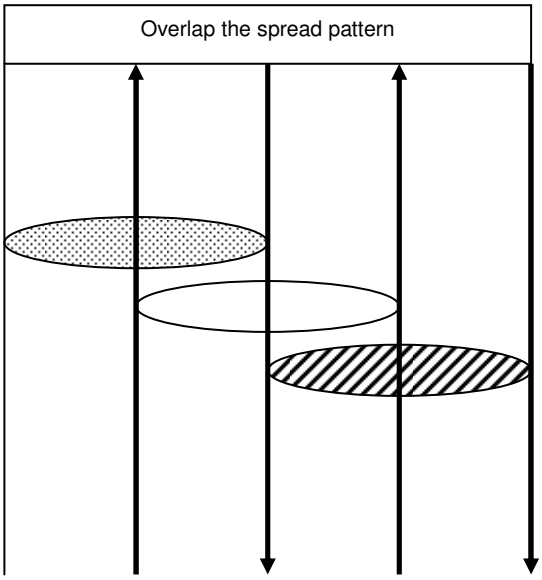
Following the Best Practices Matrix is not as good as using soil test recommendations. However, the matrix is better than no recommendations when it comes to fertilizer selection. Follow these steps to get the right amount of fertilizer applied. Remember to calibrate your spreader, or you will not be able to apply the proper amount.

1. Follow the Best Practices Matrix for your site. For example, an average quality turf, sunny site with compacted soils recommends a 4-0-2 ratio; buy something in or similar to that ratio. If P and/or K are adequate there is no need to apply them, and only N may be necessary. In these cases, fertilizers that contain only N (e.g. urea, ammonium sulfate, or corn gluten) are preferred over blended N-P-K fertilizers.

2. Follow the Best Practices Matrix to see how many pounds of nitrogen per 1,000 square feet per year are recommended.

How to apply fertilizer

Since fertilizer is applied in an overlapping pattern, the application rate should be calculated and cut in half to end up with the desired rate. In other words use a setting on your spreader that will deliver ½ of desired rate (your equipment must be calibrated to know spread rates for each setting). With the 50% overlap of the spreader, you will end up with the correct application rate. Remember that settings are not linear, for example setting 7 would not deliver ½ of setting 14. If your equipment can't be adjusted to the lower rates, adjust by driving or walking faster.



Tips, Managing, and Cleaning

Nutrient Tips

- If desired, you can leave grass clippings. This equals one application of fertilizer per year.
- Mulch leaves with the mower. As leaves decompose they will release small amounts of nutrients available for the grass plants as well as provide some organic matter to the soil - a benefit for both plant roots and soil microbes.
- Fertilize following soil test recommendations, using the Best Practices Matrix timing recommendations to provide optimal results.
- Fill granular spreaders over hard surfaces so that spills can be swept up.
- Fill liquid spreaders over vegetation so that spills can be watered down.
- Calibrate all spreaders to ensure accurate application rates.
- Don't over-water. Excess water depletes nutrients and wastes water.
- Turfgrass can use a limited amount of nutrients. Excess nutrients that are applied but not absorbed create environmental problems.

Managing properties

- Document the turfgrass quality expectations for each property.
- Follow soil test results for proper fertilizer selection.
- Follow Best Practices Matrix recommendations for application timing.
- Create a visual map of your properties. Note soil test results so that you can easily identify which formulation of fertilizer each property needs. Does mapping not work for you? Develop your own system to share information with your crew.
- If you cannot have a custom blend fertilizer for each property, look at your soil test results and group them. Buy fertilizers that meet the needs of most. If you follow the rule to not over-apply N or P, you can compromise a bit to reduce your total number of formulations. You might be surprised to see that you only need a few varieties to service your sites accurately.

Cleaning fertilizer equipment

It is important to regularly clean your equipment. When you wash equipment, make sure wash water and debris do not drain to the storm drains or to lakes and streams.

If applying by the bag instructions instead of the Best Practices Matrix or soil test suggestions, you may be applying too much fertilizer.

Apply only what is recommended. Excess nutrients contaminate lakes, rivers, estuaries, and groundwater.

Lime and soil pH

New Hampshire, and indeed most of New England, is known for our acidic soils. Oftentimes, in addition to adding fertilizer or herbicides, homeowners and municipalities add lime to their soils to make it more suitable for turfgrass health. Adding lime increases the soils pH – if soil pH is too low it restricts turfgrass growth potential. Adding lime should only be done if it is suggested in your soil test results, as too much lime is almost as damaging as too little. According to the University of New Hampshire Cooperative Extension, while native New Hampshire soils have a pH of roughly 5.2, optimum turf pH is between 5.5 and 7.0. It is important to have this optimum range met because it provides the best possible habitat for the most nutrients and minerals (nitrogen, phosphorus, calcium, iron, and healthy bacteria) to be used by the grass.

Applying lime (or limestone, as it is often referred to) is easy to apply using a drop or rotary spreader. When applying lime, make sure to cover as uniform as possible, as lime is not easily moved and often does not meander from where it is applied. Apply in two increments: once in one direction, another in a perpendicular direction to the first (columns and rows). Applications of lime last up to three years.

Application should not exceed more than 50lbs/1000sq.ft. If your soil does require an excessive amount of lime, apply in two stages three to six months apart. Calcitic and Dolomitic lime are the most common forms of lime available, and are safe and nontoxic to humans.

For more information on lime or to inquire about purchasing a soil pH test, contact the University of New Hampshire Cooperative Extension at http://extension.unh.edu/.

Ideal soil pH for turf is between 5.5 and 7.0 on a scale of 1 (most acidic) to 13 (most alkaline). A soil test will identify your soils' pH level, and will make recommendations of lime treatment to reduce acidity levels if necessary.

Herbicides

Should we use herbicides to control weeds in turfgrass? Where should we draw the line? This is a decision based on many factors, a decision for each of us to make. Most importantly, we must understand that by using chemicals to control undesirable plants, we are placing our waters at risk. Not all chemicals applied stay on target and degrade into harmless substances. Many herbicides journey far beyond the target weed they were intended to control. Some are highly toxic to fish and other aquatic life.

Herbicide facts:

- 67 million pounds of synthetic pesticides are used on U.S. lawns each year (Bormann, 1993; Greyhawk, n.d.).
- Some of the most commonly used herbicides are highly toxic to fish and/or aquatic invertebrates, including 2,4-D, Chlorothalonil, and Pendimethalin (Extension Toxicology Network, 1993; Graddick, 2009).
- Chlorothalonil is slightly toxic to humans and mammals (Extension Toxicology Network, 1993; Greater Madison Healthy Lawn Team Inc, 2003; Minnesota Department of Health, 2000).
- Dicamba, 2,4-D, MCPA, and MCPP are found in most broadleaf herbicides and widely used in "weed & feed" products. These are all found in surface water (Minnesota Department of Agriculture, 2008).

- Surfactants, or surface-acting agents, are used to help chemicals penetrate the plant surface. They are wetting agents that work by reducing surface tension and allowing the chemical to spread out and penetrate the leaf better. Some surfactants pose environmental and/or health risks:
    - May be harmful to fish. Surfactants affect the slime layer and gills of fish.
    - Possible endocrine disruptor (USEPA, 2001)
- Glyphosate (Example products: Round-up, Rodeo)
    - Slightly toxic to wild birds. Surfactant is toxic to fish.
    - Rodeo is a Glyphosate mixture without the surfactant, and is approved for water use.

In addition to threatening fish and wildlife, pesticides pose a concern for pets and humans. Children and pets are exposed to pesticides used on turfgrass. Some herbicides are even tracked into homes and can be found in dust from floors or mats at entryways and in carpet for up to one year (Greater Madison Healthy Lawn Team, Inc, 2003; Greater Madison Healthy Lawn Team, Inc., 2009; Nishioka, 1996). Some are slightly toxic to humans and mammals (Extension Toxicology Network, 1993). Proper labeling of treated areas can prevent some exposure to pesticides.

Those who use herbicides need a thorough understanding of the weed life cycle so that weed control takes place at the weed's most vulnerable time. A thorough understanding of herbicides, application rates and methods is required to use the most effective control substance and method while reducing environmental and human health risks. Everyone should focus on reducing herbicide use. The Weeds and Weed Control section and the Best Practices Matrix in this manual provide practical guidance for reducing environmental impacts of herbicides; for more information on herbicides and pesticides, visit the NH Department of Agriculture website at: http://agriculture.nh.gov/.

To avoid broad leafy weeds displacing grass, some herbicides may be necessary. In addition or as an alternative, consider overseeding to prevent weeds from taking hold and encouraging grass to fill voids (see "Overseeding" in the Lawn Care and Maintenance section, page 45).

Other Herbicide Tips

Summer Herbicide Tips for Protecting Water Quality

1. Never apply herbicides (or other lawn pesticides) to impervious surfaces in either liquid or granular formulations; this also includes weed-and-feed products and any fertilizer product

2. Never apply lawn herbicides directly to any water body. Appropriately labeled aquatic products with any necessary permits are the only means where herbicides can be applied.

3. Spraying to wet the weed foliage is usually sufficient to kill the target plants. It is not necessary to drench an area; this only increases the chance for movement into the soil where it can affect other plant root systems and thereby damage other non-target plants, or leave the site via runoff and/or erosion.

4. Keep grass clippings recently treated with an herbicide on the lawn and not blown into the street where they can be carried into the street and through storm drains to water resources

5. High temperatures will increase herbicide volatility (vaporization) thereby increasing the risk of off-site movement including into water areas and non-target plants. Follow label directions for temperatures during which the product can be applied.

6. High temperatures combined with moderate to high winds further increases the chance for off-site movement.

7. Irrigation of ¼ to ½ inch of water, or rain event, following a pre-emergence application will help incorporate it into the soil thereby increasing effectiveness and decreasing its chances for off-site movement during rain storms.

8. Avoid herbicide applications just prior to thunderstorms where intense rainfall is anticipated thereby eliminating the chances for the product to move offsite; follow label directions for how long following application the product will be rain-fast (stuck) to the weed foliage.

How do I dispose of unused herbicide?
Follow label use, storage and disposal instructions.

1. **Pressure-rinse or triple-rinse containers** immediately after emptying. Delay in rinsing pesticide containers may result in a residue that, upon drying, is highly resistant to rinsing.
2. **Dispose of empty paper bags, plastic bags and other types of containers at sanitary landfills.** Contact your local recycling and/or waste facilities for more information.
3. **Do not burn any pesticide container** in an open fire, such as in the field, in trash barrels or on burn piles.
4. **Do not reuse pesticide containers** unless they are dedicated for reuse or unless they have been cleaned according to the pesticide manufacturer's protocol and are intended to be refilled with pesticides.

Is it okay to spray on a windy day?

Read and follow label instructions. High winds will increase potential for herbicide to drift onto non-target sites. Regardless of wind conditions, even when you make applications within the wind restrictions, you are liable for herbicide damages on non-target sites. Should I keep records?

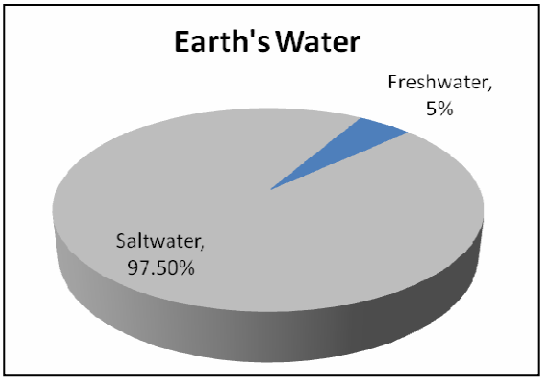
It is not required to keep records of herbicide use in New Hampshire, but keeping one may be helpful to ensure that your turfgrass receives proper maintenance at proper times of the year.

$ ***Similarly to fertilizers, you can store herbicide over the winter to save on costs. Be sure to store in a safe, airtight container, in a dry environment.***

Irrigation

On both global and national scales, humans are using freshwater faster than it can be replenished. Residents and businesses like to have green lawns in the summer, but the amount being used for irrigation (and agriculture) is more than can be sustained for the next ten to twenty years.

Here in New Hampshire we are not currently using fresh water resources faster than they can be replenished; however, seasonal "water emergencies" of available freshwater have become relatively common during the drier summer months.



Our supply of freshwater is limited.

Irrigation systems were not necessarily designed to accommodate an increase in fresh water demand, and wasting water through poorly designed landscapes or inefficient irrigation systems is a poor choice regarding environmental health (and saving money).

According to the New Hampshire Department of Environmental Services, the average New Hampshire family spends about half of their water usage on keeping their lawns healthy during summer months - many NH communities use 505 more gallons of water in the summer as a result of increased outdoor activity, much of which is put toward the watering of lawns. If wise-water irrigation techniques were put in place, the Department of Environmental Services estimates that water waste could potentially be reduced by 70% (NHDES, Xeriscaping Fact Sheet, 2010).

Using too much fresh water may cause the following environmental impacts:

- A decreased habitat for wildlife that rely on fresh surface water to survive.
- State-wide or regional water scarcity issues, with "water emergencies" becoming the norm during dry summer months.
- Changing climate will bring less frequent, more intense rainfall events, distancing the time between necessary water recharge to groundwater systems.

Using too much groundwater may cause the following environmental impacts (excess water use is described as using more than the Best Practices Matrix recommendations):

- Excess nutrients and pesticides may wash out of turfgrass areas and into surface water.
- Nutrients can be leached from plant root zones to deeper, inaccessible soil levels and to groundwater.
- Pesticides can leach through soils to groundwater.
- In weaker stands of turfgrass, soils may erode and be carried to surface waters.
- The groundwater table may be lowered, impacting wells and municipal water supplies.
- Streams may be dry or drier in the summer due to loss of groundwater that provides base flow.
- Stream life, such as fish and insects, may be harmed under dry or low water conditions.

It is true that natural precipitation can cause some of these same problems. While we have no control over precipitation, we <u>can</u> adjust for future predicted changes and <u>can</u> limit use of water by practicing responsible irrigation.

In New Hampshire, most turfgrass stands can survive without watering, although they enter a dormant "brown" stage during the summer. We are fortunate that in most areas of the state we receive adequate annual rainfall to keep turfgrass alive. Depending on your turfgrass quality expectations, additional water may be suggested. The amount of water required and the frequency of watering is covered in the Nutrients and Water section of this manual and in the Best Practices Matrix. These recommendations are scientifically based to provide adequate water for the plant and a variety of water conservation strategies for the user.

Sufficient water to support healthy turfgrass or to at least ensure survival during summer stress periods is considered a good practice. Watering beyond the plants need is both wasteful and expensive. Too often we tend to over-water our turfgrass instead of understanding the turfgrass needs and incorporating irrigation systems that are flexible enough to account for rainwater inputs and existing soil moisture. The problem may not seem that big when you look at the grounds you maintain, but consider this:

- Turfgrass covers about 49,000 square miles of land in the U.S.
- Turfgrass is the single largest irrigated crop in the U.S. by surface area (Lindsey, 2005).

To protect our drinking water, we must reduce the amount of freshwater used for irrigation. It is very likely you can reduce your irrigation water and still get the same, or even better, results.

Too much water:

- Leaches nutrients away from plant roots.
- Carries nutrients and sediment into waters.
- Wastes good, clean water.
- Lowers the groundwater table.
- Affects stream flow.
- Requires costly infrastructure (wells).

Watering needs

In Concord, New Hampshire, the average monthly rainfall ranges from 3.07-3.37" during the growing season; April sees the lowest at 3.07", while May, July, and August see the highest at 3.33", 3.37", and 3.27", respectively (although, November sees the highest with 3.57", but the ground is close to frozen at this time). Turfgrass requires roughly one inch of water per week to remain green during the growing season (see the Best Practices Matrix for site specific recommendations), so in New Hampshire additional irrigation is usually unnecessary. However, it should be noted that minor droughts are becoming more common in New England, where rainfall may not be present for weeks at a time. During these times, irrigation water should only be used to occasionally supplement the rainfall shortages and maintain active growth. It should not be done on a routine basis such as once or twice per week without considering whether or not any additional water is even needed (Climate for Concord NH, 2010).

The chart on the next page shows that the root systems of our cool-season grasses are naturally shallower during midsummer. This is primarily due to higher temperatures and drier conditions which are becoming more frequent in New Hampshire. During that period, we should be watering to wet the active root zone (typically 3 to 4" deep) of our grass plants. Deep and infrequent watering during that time will often result in water draining through the soil and beyond the active root zone and therefore wasting water. In the middle of the summer, shorter more frequent watering intervals are better so long as the lawn surface is not kept continually wet. For example, instead of applying the entire amount of water at one time, consider dividing up the weekly allotment into two or three applications, allowing some drying time between watering. This avoids keeping the soil surface constantly wet and helps ensure as deep of rooting as possible. During cooler periods of the year (i.e. spring and fall) watering can return to deeper, less frequent applications to coincide with more active and deeper rooting.

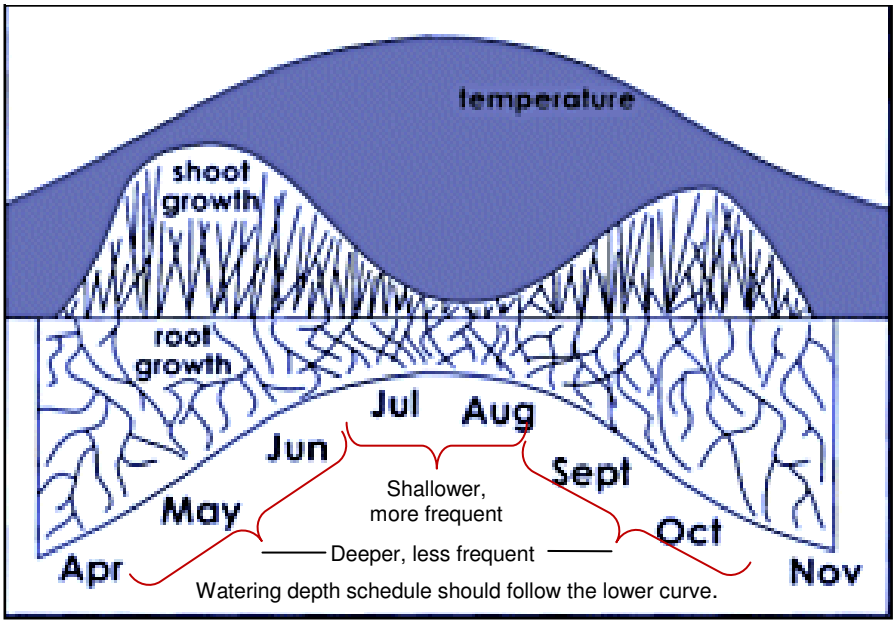
For optimum turfgrass health and reduced water use, implement an infrequent, deep watering regime, but bear in mind that "deep" will be changing during different times of the growing season.

Dormant Grass

Many turfgrass areas do not have irrigation systems. Cool season turfgrasses, such as Kentucky bluegrass, will become dormant or significantly slow their growth rates during the hot, dry periods of the summer. This is okay; however, the turf cannot withstand high use during these times. On rare occasions, persistent hot, dry conditions will kill the turfgrass. While this is a rare occurrence, it can happen where the crown or growing point of the grass plant dies as a result of the severe stress. Cool-season turfgrasses can withstand the loss of roots and leaf tissue during severe stress periods. However, if the grass crown also dies, the plant is lost, as it has no way to generate new shoot or root tissue.

There is no sure way to visually pinpoint when turfgrass is approaching (or has passed) its threshold of survival. However, it is important to remember that a dry, brown turfgrass area is considerably warmer than an actively growing, green turfgrass. The main reason for this is that in the brown, dry turfgrass there is no transpiration, and therefore, no evaporative cooling occurs to reduce temperatures in and around the plant. The consequent heat build-up in and around the plant can reach levels fatal to all plant tissue, including the crown tissue. The best strategy is to condition your turfgrass. Conditioning turfgrass to warmer, drier conditions is very important to its survival. Conditioning means that water and nitrogen supplies are gradually reduced ahead of the summer stress periods to "condition" the turfgrass to slower, more stressful growing conditions.

Irrigation for cool season grasses



Adapted from Graphic Source: University of Minnesota, 2006

Un-irrigated sites cannot tolerate high traffic during hot, dry conditions. When possible, reduce traffic to the area during hot, dry conditions.

Do not apply excessive amounts of water just before an impending watering restriction as a means to "build-up" plant and soil water reserves. In reality, this practice not only increases plant succulence (i.e., the plant now requires high levels of moisture to sustain this condition) but excess water can lower soil oxygen, which can severely damage the root system. Both of those attributes severely decrease the plants ability to tolerate summer stress and in general are very wasteful of water. In other words, this has a "deconditioning" effect on the plant, making it more vulnerable to injury or even death during hot, dry summer conditions.

If you allow turfgrass to go dormant during summer stress periods, then supplying some water – ¼ to ½ inch every 10 days to two weeks – will usually keep the crown tissue alive to re-grow under more favorable conditions. However, when temperatures are consistently in the nineties or even low one-hundreds with no rain forthcoming, that interval should be shortened. Likewise sandier soils will require somewhat more frequent watering than heavier clay soils due to differences in soil water-holding capacity. In addition, severely compacted soils will need shorter intervals than non-compacted soils, where root systems can be significantly deeper and mine a greater soil volume for moisture reserves.

Even when appropriate steps are taken to preserve turfgrass from dying during periods of summer stress, some permanent injury can still occur. This can be an opportunity to do over-seeding to introduce more drought-tolerant species. That can help reduce future moisture needs as well as other inputs.

Save our water by continually adjusting your irrigation system, depending on rain and soil moisture. Stay within Best Practices Matrix watering guidelines.

More efficient watering

To get the most water to the plant and reduce water lost to evaporation or waste:

1. Water in early morning. Grass blades need to dry out to minimize disease pressure.
2. Water close to ground and with larger drops.
3. Water slowly, deeply, and less frequently. Root growth is influenced by water depth and time of the year. Frequent shallow watering that keeps surface soils wet encourages shallow root growth, greater proneness to certain diseases, and reduced stress tolerance. Monitor irrigation systems. Make sure water is not lost by landing on or running off the turfgrass onto hard surfaces and the nozzles are the correct type for the turfgrass space.
4. Leave clippings and mow at higher heights to reduce moisture loss and irrigation needs.
5. Aerate turfgrass to improve water infiltration into the soil and increase soil oxygen levels deeper into the soil; both have positive impacts on root growth and soil microbial action. Deeper, more robust root systems combined with increased soil water-holding capacity will decrease the need for frequent supplemental watering.

Do you need more water?

Use a rain gauge to measure rainwater, take this amount and subtract it from the weekly watering recommendation from the Best Practices Matrix. Add only the amount of additional water that is needed. Often that will be zero. How can you control how much water is delivered? Calibrate irrigation system and adjust settings accordingly. Read and understand settings of irrigation system for delivery capacity. Install rain sensors to avoid watering during the rain. Install moisture sensors to avoid watering when soils are moist. Frequently adjust irrigation systems to account for recent rain, prevailing weather conditions, and season of the year.

Maintenance

Irrigation systems should be set up properly and checked frequently. Weekly inspection along with performing necessary maintenance is ideal, especially on systems that are not computer controlled and cannot account for the amount of rainwater received. Items to check include:

- Heads are working properly.
- Water is not directed to hard surfaces. One cycle does not create surface runoff from turfgrass areas.
- Programmed for early morning.
- Upgrade if your system cannot be controlled to deliver the right amount of water (rainfall considered), to obtain Best Practices Matrix recommendations.
- Verify that your schedule complies with city watering restrictions.

Upgrading your systems
Consider updating your irrigation system to include features such as rain sensors, soil moisture sensors, and smart scheduling that deliver only the required amount of moisture per week.

Signs of overwatering

It is far more common to overwater than underwater irrigated turfgrass.

- Yellow nutsedge appears more frequently in turfgrass (triangle shaped stem).
- Water-loving weedy grasses (annual bluegrass, rough bluegrass, creeping bentgrass) may start to appear and increase in area that they occupy.
- Soil is consistently moist to the touch.
- Problems with clumping clippings when mowing.
- Water running over the curb and/or down the street.
- Standing water in low areas.
- Pale-looking grass due to lack of nutrient uptake under persistently wet soils.
- Soil leaving (eroding from) the site.
- Mower tracks persist due to weak shoot and stem tissue that is slow to pop back to an upright position. Also occurs in dry conditions: see below.
- In wet conditions, plants are typically green but very succulent due to high moisture levels.

Signs of under-watering

- Turfgrass does not need much additional water to survive in New Hampshire. Non-irrigated turfgrass areas are common and are explained in the Best Practices Matrix.
- For irrigated areas, a common sign of under-watering is a change of color from a healthy green to grayish-green or grayish-blue. This may be visible over the entire lawn or between irrigation zones where there is insufficient overlap to meet the water needs.
- Mower tracks and foot printing.

Add a rain or soil moisture sensor to your irrigation system-you'll use less water (the right amount) and save money. **Neglected turfgrass areas can cause soils, with attached nutrients and pesticides, to erode and contaminate our waters.**

Keep leaves and clippings off of paved surfaces. Take care, also, to wash mowers and other equipment inside or over vegetated areas so that soil, grass clippings, oil and greases are not washed into the storm drain.

LAWN CARE AND MAINTENANCE

The best time of the year to prepare for upcoming turfgrass maintenance is before the growing season starts. It is the time to tune up equipment, sharpen mower blades, calibrate herbicide and fertilizer spreaders, and train your crew. Take advantage of slow times of the year to prepare site assessment forms, maps, maintenance checklists, and to research updated turfgrass maintenance methods, tools, and equipment.

Calibration

The Best Practices Matrix and your soil test will help guide you in understanding target amounts of fertilizer and specific nutrients your grass needs. Calibration of equipment is essential for measuring the amount of material of (e.g. fertilizer or herbicide) being delivered at any given setting. This should be the backbone of your maintenance program. By calibrating equipment, waste and costs of material will be reduced, performance will be enhanced, and environmental impacts will be reduced.

Calibration tells you how much material will be applied at each setting.

You can calibrate any type of equipment (e.g. backpack sprayers, handheld sprayers, rotary spreaders, drop spreaders, etc). Calibration is what separates the top-performing organizations from the average performing organizations!

The University of New Hampshire Cooperative Extension has instructions on calibrating fertilizer and injector equipment. There are two common calibration methods: flow method and EC method. The flow method is a physical calibration, while the EC method checks the concentration of soluble salts in the discharged water. For more information on both practices, visit http://extension.unh.edu/resources/files/Resource000882_Rep928.pdf.

For a video on how to calibrate your fertilizer injector, created by UNH, visit: http://www.youtube.com/watch?v=3fzobTdmkh8&list=UUP15ui7R8clKcMIP1E0W1pw&index=22&feature=plcp.

Calibration guidelines

Good programs include calibration of equipment.

- Calibrate each piece of equipment yearly.
- Calibrate new equipment.
- Calibrate for each granular product; different materials flow differently.
- Calibrate for every setting within your range of application rates.
- Place calibration card in or near equipment for easy access.
- For specific calibration directions, contact the manufacturer of the spreader or sprayer.

Adjust application rates

- For most equipment, application rates are adjusted by walking or driving faster or slower.
- Application rates are also adjustable by changing the setting.

Equipment

- When buying new equipment, look for equipment that can deliver low application rates.
- Calibration tools that measure slot size of a spreader do not replace calibrating the equipment, nor do they guarantee the correct application rate.

Calibration is a great way to improve your operations, save money, and protect the water.

Sweeping

Sweeping hard surfaces such as roads, sidewalks, and parking lots is a simple way to reduce water contamination. Everything on hard surfaces drains to the street, through the storm drain or ditch, into the nearest lake, pond, wetland, or river.

Sweep frequently

- Sweep as often as you can. A year-round program is optimal.
- Sweeping makes a good impression. If your hard surfaces look good, everything will appear better maintained.
- Be proactive. Keep sand, salt, clippings, seeds, leaves, and debris from entering our storm drains. Plant parts act as fertilizers in our waters. As they bio-degrade, they release nutrients that turn the lakes green. Dirt entering the storm drains accelerates the aging of our lakes, and things like oil and salt act as toxins to our aquatic systems.

Dispose of sweepings properly

There are several options for sweepings disposal:

- Dispose of sweepings in a landfill.
- Take sandy sweepings to a facility that will re-use the material (i.e. asphalt companies).
- Screen sandy sweepings and reuse the screened sand as construction fill.
- Organic sweepings (grass, leaves, and seeds) can be composted.
- Do not dispose of sweepings in low areas, lakes, streams wetlands or holding ponds, or where rain will wash them to the stormdrain or ditch.
- Do not dispose of sweepings where children play.

Power Raking

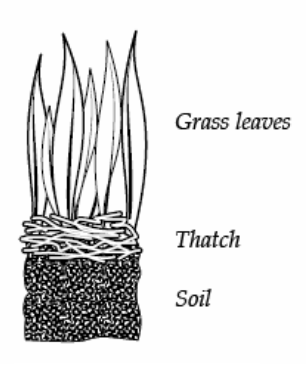
Power raking can be useful as a spring clean-up tool to remove sand and debris from turfgrass and fluff up the grass blades. This process does damage turfgrass plants, but recovery is usually quite rapid during this period of the year. To reduce damage to turfgrass, make sure the raking is done lightly (shallowly) and not deeply. Power raking:

- Should not be done routinely, but rather only if conditions warrant.
- Is performed only in the spring.
- Does NOT reduce thatch.
- Is stressful to turfgrass plants.

- Stands grass up, thereby opening up the turfgrass canopy, allowing sunlight to reach the soil surface where soil is warmed and early spring grass growth is encouraged.
- Clears out debris and dead vegetation.

Thatch

Thatch is the dark brown, felt-like, fibrous layer between the soil surface and where the grass shoots become visible. It is a normal and necessary part of a turfgrass system. It helps insulate turfgrass from rapid changes in soil temperature and moisture; however, if it is too thick, it can impede water, nutrient, and air penetration into the soil, which causes reduced root growth and/or rooting up into the thatch layer and increased potential for drought stress.



Fagerness, 2001

How much thatch do you need?

- A thin layer of thatch is good – less than ½ inch. This is very common.
- A thick layer of thatch is bad – more than ½ inch. This is very uncommon.

Preventing thatch build-up

- Avoid excessive amounts of nitrogen.
- Avoid frequent, shallow watering that keeps the surface soil layers consistently too wet.
- Avoid overuse of pesticides, especially fungicides and some insecticides (avoid them all together if possible).
- Core aerate frequently (at least once/year).
- Leave grass clippings.

Managing thatch build-up

- Verify that you really have a thatch problem.
- Core aerate frequently as needed.
- Use a vertical mower. It will vertically slice through the thatch layer, pulling it to the lawn surface. It can then be raked off.
- Do not use a power rake, such as those used for clean-up in the spring, to remove thatch. This is not effective at true thatch removal and can cause significant turfgrass injury. (Note: some vertical mowers are known or even labeled as power rakes. If renting or purchasing a unit, make sure it really is a vertical mower.

Aeration

Aerating your turfgrass is excellent for maintaining healthy turfgrass. Aeration fights soil compaction, improves water infiltration, promotes healthy root systems and healthy soil microbial communities, and prevents thatch build-up.

Best Aeration Practices:

- Core aeration is the best method.

- Autumn is the best time to aerate.
- Spring is the second best time to aerate; however, aerating in the spring can make turfgrass susceptible to weed invasion.
- Penetrate 2-3 inches into the soil.
- Aim for 20-40 holes per square foot (this requires more than one pass, 40 holes/ft = 20% of area).
- Leave cores on the surface. Mow the cores if needed, but do not bag or collect them. Note: this may dull blades a little more quickly. However, if blades are sharpened regularly, it should not be a significant problem.
- Make sure all tines are unclogged and available for aerating.
- Aerate close to sidewalks and paths where compaction is likely, but be careful not to aerate over concrete, asphalt, tree roots, irrigation systems, cable lines, etc. Mark these areas.

When not to aerate:

- Avoid aerating dry or stressed turfgrass.
- Avoid aerating non-irrigated sites if hot, dry, windy weather is predicted.

Seeding

Selecting the right seed to match your growing conditions is the key to success. Use a good quality seed. It may cost more, but it will be more successful and save money in the long run.

What to look for on seed label:

- Percent germination. You want greater than 80% germination. Multiplying the percent germination by the seed purity will give you the expected amount of seed that will actually grow. This figure is termed the "pure live seed" of that variety in the seed mix. Collectively, it can be used to determine the amount of pure live seed in the entire mixture. One can determine the amount of seed to purchase based on the amount of pure live seed contained in the seed blend or mix. See a more detailed description of this calculation at the end of this section.
- Percent weed seeds. Look for 0.5% or less (ideally 0%) weed seeds. (Look carefully. You want 0.5% or less, not 5.0% or less).
- Percent inert material. Look for less than 4% inert material. Inert materials are fillers or non-seed items, such as chaff and hulls. They will not grow under any circumstance.
- Noxious Weeds. Make sure the mix does <u>not</u> include noxious weeds.
- Date tested. The seed should have been tested within the last 9 to 12 months.

What type of seed to buy

- Annual – will only grow this year. Often annual grasses will green up faster and hold soils until perennial grasses come in. The annual grass most often included in a grass seed mixture is "annual" or "Italian" ryegrass.
- Perennial – will grow this year and beyond; the mainstay of your turfgrass system.
- Check the Best Practices Matrix for seed mix recommendations based on turfgrass expectations and site conditions. Also refer to the Resources section under “Seeding”.

Seed based on sunlight

The most common difference between sunny and shady seed mix is the ratio of fine fescue and/or ryegrass to Kentucky bluegrass. For more detailed information on grass seeds and their preferred conditions, visit the University of New Hampshire Cooperative Extension website (listed in the references section).

For sunny conditions with moderate to high maintenance conditions, the Extension suggests the ratio of Kentucky bluegrass to perennial ryegrass to fine fescue be 50% - 25% - 25%, respectively. With lower maintenance conditions, it is recommended that the fine fescue percentage increase to 50%, with perennial ryegrass and Kentucky bluegrass both at 20%,with the remaining 10% consumed of Dutch white clover.

For shady sites, it is recommended the amount of fine fescue should be highest, at 70%. The remaining 30% should be made up of perennial ryegrass (20%) and Kentucky bluegrass (10%). Ryegrass does well in New Hampshire (specifically the coast, where the winters are milder), and can tolerate partial shade. Fine fescue does not hold up as well in high traffic and other extreme conditions. Be aware that annual ryegrass in your mixture can help as a cover crop but can also shade and outcompete the perennial grasses that you are trying to establish. Thus, begin mowing early, even if the other grasses are just getting started, to avoid the possibility of too much shading and competition from perennial (or annual) ryegrass.

What is a fine fescue?

A fine fescue is a narrower, finer-leaved turfgrass plant. They are characterized by their good adaptability to dry conditions, low nitrogen levels, and reduced mowing, but they are less hardy than ryegrass for New Hampshire's cold winters. They are also somewhat shade tolerant. Some common species of fine fescues are creeping red fescue, chewing's fescue, hard fescue, and sheep fescue. When you look at a seed mix it won't say fine fescue, it will list the actual type of fine fescue.

Some fine fescue mixes, often called "low-mow" or "no-mow," are excellent for low-use areas. They do not require weekly mowing.

When to seed

The best time of year to seed is between mid-August to mid-September when weed competition is lower and environmental conditions are more favorable. See the Best Practices Matrix for seeding time recommendations.

How much seed do you need?

Three to five pounds of seed per 1,000 square feet is typical for Kentucky bluegrass, fine fescue, and perennial ryegrass mixtures. In general, the more Kentucky bluegrass in a seed mix, the lower the seeding rate can be. More is not better. Too much seed can result in excessive competition between the plants and slower establishment. Read seed label for seeding rate recommendations.

Over-seeding

The process of sowing more grass seed over the top of existing turfgrass is called over-seeding. The following steps will increase your success in over-seeding. See "Seeding" in the Resources section of the manual for a comprehensive description of lawn rejuvenation. Here are the basic steps:

- Mow existing turfgrass shorter than usual
- Remove clippings
- Core-aerate to relieve soil compaction and/or bring soil to the surface. A brisk raking or vertical mowing to loosen the surface soil will also help provide a more favorable seedbed. Anything to ensure good seed to soil contact will help in getting the turfgrass established.
- Sow seed. Select mix appropriate to your sun/shade conditions. No need for annual grass seed in this mix.
- Water lightly but consistently once or twice a day for at least 2 weeks to wet soil, but do not allow soil to become soggy. If seeds or new grass plants dry out during this seedling phase, you will not be very successful.
- Keep existing turfgrass mowed short (about 2½") during this time and gradually raise mower height as new seedlings catch up to the existing turfgrass height.

Over-seeding is one of the best and most environmentally safe herbicides. Grass and weeds can't occupy the same spot. The best time to over-seed is late summer/early fall, or late winter/early spring. More grass, less toxins!

Mowing

Mowing strategies are influenced by many factors: the rate of turfgrass growth, the availability of the mowing crew, and the weather, to name a few. But our mowing decisions should also consider the plant's life cycle, health, and growth factors. Integrating science and maintenance will give the best results for the lowest cost.

Turfgrass grows approximately 1/10 of an inch per day.

Avoiding plant damage

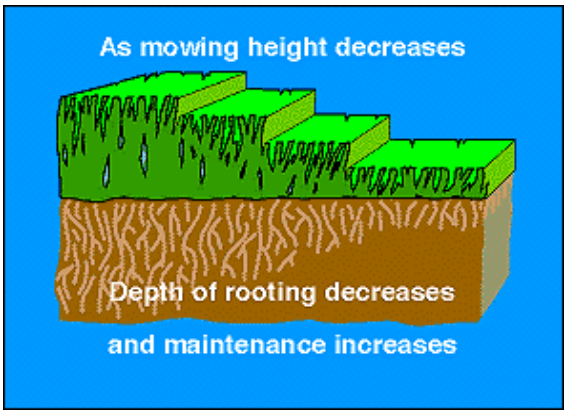
To keep the turfgrass healthy, adopt strategies to reduce plant injury. Mowing improperly can cause rips, tears, or cuts in the plant and increase its susceptibility to disease. Damage to plant tissue reduces the plant's ability to photosynthesize. Here are tips for reducing damage:

- Keep blades sharp. Sharp mower blades reduce shredding of the turfgrass plant. Sharp mower blades are especially important during the flowering stage of the plant. At this time the seed stalk is sent up. The stalk is tougher and harder to cut through. With dull blades, damage to the plant is more pronounced.
- Avoid mowing during extremely dry periods. The soils sandblast the turfgrass, which is already under stress from drought conditions.
- Avoid mowing in extremely wet conditions. As the mower turns (e.g. around trees), the tires can tear out the grass plants. The soils are also more prone to compaction.
- Change mowing patterns. Turfgrass is stressed by constant repeated mowing patterns.

- Keep mowers away from base of trees and off of the tree's root zone to prevent tree damage. Mulching around the base of trees can help. Use a 2 to 4 inch depth of mulch, extending 3 to 6 feet out from the trunk, hollowed out around the base of the tree for air and water exchange. Do not mound mulch up against the tree trunk.
- Be aware that it is possible to permanently damage the grass crown and therefore kill the plant if the turfgrass is driven on when in severe drought stress or frozen. Walking or driving over the turfgrass when there is frost on it can also cause significant injury to the foliage and even the crown. Damage is evidenced by the distinct brown/tan footprints or tire tracks left through the turfgrass area.

Taller turfgrass:

- Produces deeper roots, which is the key for survival in low water periods. Deeper roots can absorb more nutrients. Deep roots produce strong plants.
- Has greater surface area for photosynthesis, the energy-making system in plants.
- Requires less frequent watering. Deeper roots and longer grass blades store more moisture, create more shade and reduce transpiration.



University of Minnesota, 2006

$ ***Taller turfgrass will be healthier and requires less water and fertilizer.***

Maintenance and Cleaning

With frequent blade sharpening comes the opportunity to reset the deck height on mowers. Every time the blade is changed, think about what is the best deck height for the conditions rather than keeping the deck height stationary all year long.


Photo courtesy of Jim Weber

Setting deck height

- To reduce plant stress, the tallest heights should be in the hot stressful time of summer, giving the plant the full advantages of shade, moisture retention, and photosynthesis.
- On average, set deck to 3 inches. See recommendations in the Best Practices Matrix based on time of year, soil type, exposure, and turfgrass quality expectations.
- Double check your work. After adjusting blade height, mow a strip and measure the blade of grass to make sure that it is cutting at 3 inches.
- Incrementally change mower height. Large changes are stressful on the plant.

Trim less than ⅓ of the turfgrass blade

Mowing shocks turfgrass, especially if it is a major cut. The grass blade will use all of its energy to repair itself. In addition, the turfgrass will produce less energy through photosynthesis because much of the grass blade has been removed.

- If you are mowing overgrown turfgrass, mow it a couple of times a few days apart to reduce the shock and stress on the plants.
- Double mow:
    - To reduce thick clipping layer.
    - Change mowing pattern on second pass.
    - Lift up the deck for the second pass, especially when double mowing on the same day. Cutting twice at the same height and different angles could cut or tear each blade of grass again, or just brush the top, which will damage the plant as well.

Mower blades

- Blade must be sharpened straight, never curved.
- Only sharpen one side of the blade.
- Make sure blade stays balanced, equal weight on both sides.
- Dull blades use 22% more fuel.
- Dull blades or grass-coated blades tear the turfgrass and give it a whitish cast.
- Blade "wings" or foils point up, or blade is on upside down.

Leave clippings and leaves on turfgrass

- Grass clippings equal one application of nitrogen per year and reduce fertilizer needs.
- Grass clippings and mulched leaves will help retain moisture.
- Discharge clippings onto turfgrass, not sidewalks or hard surfaces that drain to the nearest pond, lake or river.
- Sweep or blow clippings from hard surfaces back into turf areas.

Cleaning equipment

Here are a few tips on cleaning your lawn equipment:

- Use compressed air or rinse mowers on the grass to avoid water runoff.
- Don't allow wash water and debris to enter storm drains (they drain to a lake or stream). Collect water and dispose in sanitary sewer or use inlet protection devices to filter water and capture debris.
- Cover air filters before cleaning with water.
- Make sure hard surfaces are swept up after cleaning mowers.

Leaves

Mulched leaves can provide benefits for the soil and turfgrass plants, but they must be managed in a way that the turfgrass is still visible and able to photosynthesize.

Always mow or mulch leaves

- Remove some shredded leaves if covering more than 50% of the turfgrass plants.
- Be careful that mulched leaves remain on turfgrass and are not blown onto the road, sidewalk, or other hard surfaces where they can enter stormdrains.

A study conducted over several years at Purdue University shows that using a rotary mower to mulch leaves into the lawn has no detrimental effect on turf health. The mulched leaves may, in fact, improve soil conditions (Reicher & Hardebeck, 2000).

Benefits of mulching leaves

- Saves time collecting leaves.
- Saves the cost of hauling leaf litter away.
- Biodegradable on site, no need to have extra burden on compost sites.

Disposing of leaves and seeds

- Mulch on turfgrass, spread to cover less than 50% of turfgrass in any one spot.
- Bring extras to a compost site.
- Haul leaves securely covered.
- Do not leave plastic bags at compost site
- Do not put in low areas, wetlands, or holding ponds.
- Do not put in woods unless you can spread them in a thin layer.
- Tree seeds are a large source of phosphorus. Sweep them out of the street and compost them. Do not dispose of in natural areas.

WEEDS AND WEED CONTROL

Weeds

Weeds can be controlled more efficiently if we understand their life cycle and attack them at their weakest stage. By applying science to turfgrass management we can get the same results with less work, less money, and more environmental protection. "Integrated pest management (IPM) is an approach which first assesses the pest situation, evaluates the merits of pest management options and then implements a system of complementary management actions within a defined area. The goal of IPM is to mitigate pest damage while protecting human health, the environment and economic viability" (MDA, 2010). Integrated weed management is a subset of IPM. Management techniques include cultural, mechanical and chemical methods.

Most weeds can be divided into four categories. By understanding each plant's life cycle we will have the insight to control them at the optimal time.

- Annual grass weed
- Perennial grass weed
- Annual broadleaf weed
- Perennial broadleaf weed

Weed management diagram

For best management you will need to know if your weed is an annual or perennial plant and if it is a grass or broadleaf plant. A plant is perennial (lives more than 1 year) or annual (lives only 1 year). Control options are recommended based on the plant's lifecycle. Herbicides have been developed to take advantage of the biological differences between broadleaf plants and grass plants.

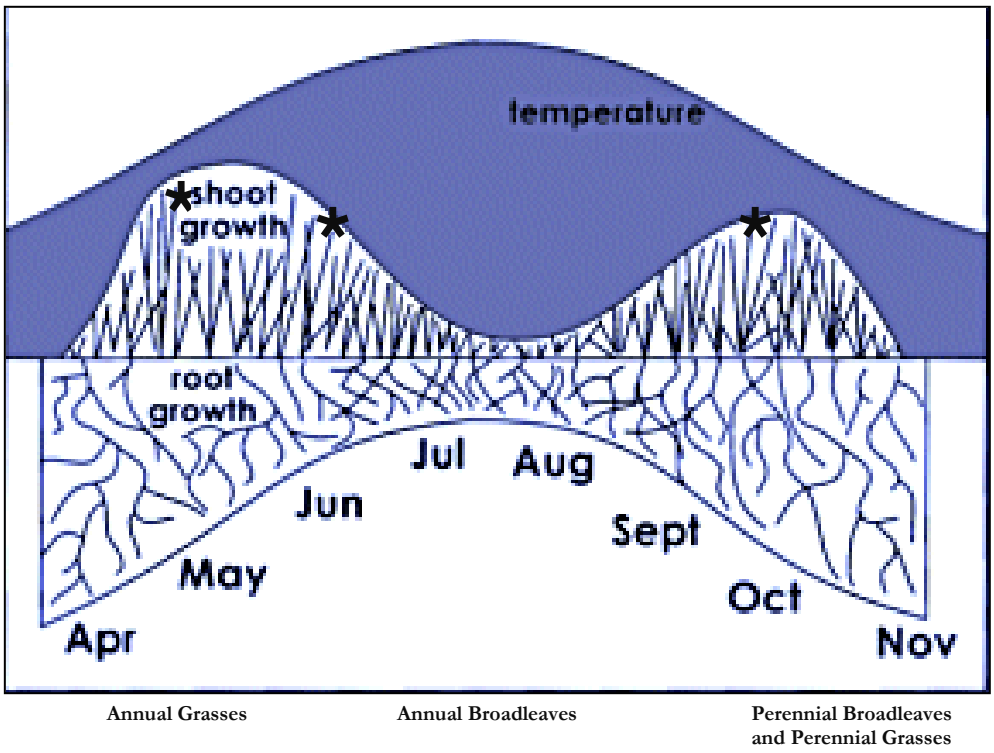
General weed control information

Weeds often grow where turfgrass is thin and weak. The best control of these plants is to figure out why the area is stressed or disturbed and fix the underlying cause. Allowing a mix of broadleaf plants and perennial grasses is often recommended, especially in areas of heavy shade or in other stressful growing conditions such as the boulevard between the road and sidewalk. A mix of plant types will help hold your soils and prevent erosion. If this look is acceptable, use mowing as your control. It will go a long way in blending the different plants into an acceptable look. For example, violets are considered by some to be weeds and others to be treasures; however, they can be used successfully to compliment turfgrass in shady areas by increasing plant density.

Treat only problem areas with herbicides, not the entire turfgrass surface.

Avoid using weed-and-feed mixes. The optimal timing for fertilizing usually differs from the best time for weed control. Refer to the Best Practices Matrix for timing guidelines.

Weeds may be acceptable in difficult sites, such as boulevards. Use mowing to indicate the site is well maintained.



Adapted from Graphic source: University of Minnesota, 2006

For photos of common weeds and other plants, see the "Common Weeds" photos later in this section and visit the University of New Hampshire Cooperative Extension websites listed in the Resources section of this manual.

Weedy Grasses

Manage annual weedy grasses in the spring

Grasses are monocots (plants with long slender leaves). Because they are monocots, they biologically function differently than dicots (broadleaf plants). The type of herbicide used to selectively kill dicots will not harm grasses.

An annual grass differs from a perennial grass in that it only lives one year. It germinates from seed in the spring, grows, puts on a seed head, and dies. Some annual grasses are desirable, and in seed mixes, some are not so desirable. The undesirable varieties often appear in disturbed or stressed areas of turfgrass.

Control Measures

- If you believe you must use an herbicide, the best approach is to use a pre-emergent herbicide before soil temperatures reach 55 degrees. Timing is critical. The herbicide must be present before the seedling pops through the soil. If the herbicide is applied too early it will not be present during emergence, and if applied after the plant has emerged it will have no effect.
- Monitor soil temperatures
    - Invest in a soil thermometer. Insert soil thermometer one inch into the ground to monitor temperatures near the seed bank. Do not insert soil thermometer to the full depth of the shaft. Take readings in the morning before the sun warms the soil to get a better reading.

- Average soil temperatures across New Hampshire and throughout New England can be found on the New England soils climate index website (see references for link). These soil temperatures are taken at a 4 inch depth so they will not be the same temperature as the 1 inch depth.
- According to the UNH Cooperative Extension, to determine if your soil is ready for planting, pick up a handful of soil and mold it into a ball. If the ball sticks together it is too wet and will not provide good results from planting; if the ball crumbles in your hands it is ready for seed.
- Soils warm up faster near hard surfaces. This is also where there is often an annual grass weed problem. Make sure you monitor soil temperatures in the area where the weed problems exist. Soil temperatures will likely drop as you move away from heat sinks such as sidewalks and buildings.

Common annual grassy weeds

- Examples: barnyard grass, fall panicum, giant foxtail, large crabgrass

Manage unwanted perennial grasses in the fall

Grasses are monocots, and there are no herbicides that will select one grass plant over another. That is bad news for controlling perennial grassy weeds. A perennial grass differs from an annual grass in that it comes back year after year. Because their lifecycle is the same as most of our desired turfgrass species, there are no selective control methods.

- The last and most drastic approach is a non-selective herbicide. This will kill all vegetation, and you will have to start over. Fall is the best time for this activity since the plant's energy is being directed downward to the root system and will more efficiently carry the herbicide to those same areas, resulting in better kill of the below-ground reproductive structures.

Common unwanted perennial grasses:

- Examples: reed canary grass, quackgrass, timothy

The USDA has a list of all invasive species in New Hampshire, including grasses, weeds, and other plants. See the Resources section under "Weeds and Plant Identification".

Broadlfeaf Weeds

Manage annual broadleaf weeds in early summer

Broadleaf plants are dicots. They are called a broadleaf because they have a wide leaf, unlike a grass blade. They are susceptible to herbicides that do not affect monocots. The challenge with broadleaf control is to determine if you have annual broadleaf weeds or perennial broadleaf weeds. To minimize herbicide use and maximize weed control you must first properly identify which type of broadleaf weeds you are intending to control.

Spot-treatment uses less chemical. That's better for the environment and may save money.

Since broadleaves are a completely different type of plant, it makes it easier for us to control them without disturbing turfgrass. Annual broadleaf plants live only one year. They germinate from seed each year. The

seed grows into a plant; it flowers, seeds, and dies. Broadleaf herbicides are specifically formulated to kill broadleaf weeds (both annual and perennial) without harming turfgrass.

- If you feel you must use an herbicide, the best approach is to use a post-emergent herbicide when the plant is very young and weak. The proper time to apply early post-emergent herbicides to control annual broadleaf plants is in June.

- If the plant has gone to seed, do not use herbicide. The damage has already been done; the seed is set for next year's growth. The adult plant you intend to kill will die without herbicide at the end of the growing season.

Common Annual Broadleaf weeds:

- Examples: cocklebur, lambs quarters, ragweed, velvet leaf, prostrate spurge, knotweed

Manage perennial broadleaf weeds in the fall

Perennial broadleaf weeds and broadleaf plants return year after year from their roots. Since these dicots are living amongst our turfgrass (monocot) plants, we have the ability, if needed, to use herbicides to selectively remove them without harming the turfgrass. Reduction of herbicide use is needed across the board to protect our lakes and rivers. Here are some strategies for controlling perennial broadleaf weeds:

- If you feel you must use herbicide, it is most effective to treat perennial broadleaf plants in the fall. It is most tempting to treat broadleaf perennials during their showy bloom stage. However, this is not the most effective time. Save your herbicide until it will do more good. During the fall, the plant's energy is directed toward its roots. It is the most effective time for herbicides, and you will be most successful at weed control.

- Treat only the problem areas with herbicides, not the entire turfgrass surface.

Common Perennial Broadleaf weeds:

- Examples: dandelion, broadleaf plantain, Canada thistle, clover, birdsfoot trefoil, creeping Charlie

If you know the name and type of weed you have, you can control it with the least amount of chemical and effort. Take time to identify your most troublesome weeds and determine which of the four main categories they belong.

Note: *This manual does not cover pests such as insects and diseases. To find information on these topics, see the University of New Hampshire Cooperative Extension website (http://extension.unh.edu/), the New Hampshire Department of Agriculture (http://agriculture.nh.gov/divisions/pesticide_control/index.htm), or the New Hampshire Division of Pesticide Control (http://agriculture.nh.gov/divisions/pesticide_control/index.htm).*

Common Terms Associated with Weed Biology and Growth

Growth cycles

- Annuals (Summer annuals) – germinate in the spring, grow, flower produce seed, die
  Examples – prostrate knotweed, annual or common chickweed

- Biennials – grow from seed the first year and form a rosette, overwinter in that state followed by flowering the next spring or early summer, produce seed, die
  Examples –common mullein, bull thistle, musk thistle

- Perennials – live from year-to-year surviving primarily by root systems that grow and produce both flower stalks and new vegetative structures each year
  Examples – dandelion, broadleaf plantain, clover, ground ivy, yarrow, Canada thistle, mousear chickweed

Growth Habits

- Upright – vegetative and/or flowering stems extend vertically, not forming rosettes
  Examples – redroot pigweed, yellow woodsorrel

- Spreading – stems spread laterally over the ground surface; stolons (above ground) and rhizomes (below ground) are specialized stem structures that root at the nodes and give rise to new plants
  Examples – white clover(s), ground ivy(s), Canada thistle(r), common yarrow (r), mousear chickweed, prostrate spurge, wild blue violets (r)

- Basal leaf clusters (rosettes) – circular cluster of leaves formed around the stem at ground level
  Examples – dandelion, plantain, many of the mustard family plants

Rooting characteristics

- Taprooted – usually a large, fleshy vertically oriented root; occasionally taproot is thin and not as fleshy as in prostrate knotweed or birdsfoot trefoil
  Examples: dandelion, common mullein, redroot pigweed, many of the mustard family plants

- Fibrous rooted – thin roots arising from nodes along a spreading stem or from root tissue
  Examples – mousear chickweed, plantain, ground ivy, clover, common chickweed, wild violets, many others

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UNIVERSITY OF MINNESOTA EXTENSION

Weed Control

Any plant may be a weed to one person and a desirable plant to another. When we look at weed control we should look at our level of weed acceptance. It is not affordable or sustainable to remove every plant that is not turfgrass. As we are more accepting of plant diversity and smarter about weed control, the less herbicide we will need.

There are many methods of weed control. Weeds can be managed manually, mechanically, and chemically. Weed control can be frustrating, time consuming, and expensive. By understanding the life cycle of the weeds and the turfgrass you can be more strategic in their control. As a professional turfgrass maintenance expert you have the ability to influence the expectations of the public and your customers. By helping them set sustainable expectations, weed control can be much more ecologically sound. By applying plant science to weed control, you and your crew can manage weeds responsibly, efficiently, and effectively.

Accepting some weeds

What is your or your client's tolerance toward weeds? Can you live with "other" plants mixed into turfgrass? Some plants can be helpful to turfgrass. Clover, for instance, puts nitrogen back into the soil; and nitrogen is an essential nutrient for turfgrass. The two species grow well together and reduce the need for external fertilizers.

We are so accustomed to turfgrass that we force it to grow in sites that do not favor its growth, like shady sites, hot dry sites, sites with poor soils, and so on. Given harsh site conditions, weeds are more common. The effort to grow pure turfgrass in harsh sites may be time, cost, and environmentally prohibitive. In these sites other plants should be welcomed. You can control the plant community. For example, violets growing within turfgrass are more acceptable than thistle. Sites can be managed for a mix of plants.

Consider grasses and wildflowers for sites where turfgrass does not grow well. Native species do not require any additional fertilizer or watering on your part!

The density of weeds should be considered. A chemical attack for a single weed here or there is not ecologically responsible. Fortunately, the cost for this type of management discourages this practice. If cost is not a limiting factor for your clients, educate them on the environmental costs and see if you can change their expectations.

Maintain healthy turfgrass

Healthy, dense turfgrass is the best defense against weed invasion. Weeds thrive in degraded or weakened turfgrasses. Remember that overseeding or sodding can be an excellent practice in helping reduce weed invasion. By incorporating many of the practices discussed in this manual, you can increase the health of your turfgrass and lower your use of herbicides.

Healthy, dense turfgrass is better for the environment than neglected turfgrass.

Mowing

Not all weeds need to be removed. Some serve a good purpose in increasing vegetative coverage and reducing erosion. Areas that likely have a variety of plants mixed into turfgrass are shady areas and areas of harsh growing conditions such as boulevards and road edges. In these examples, mowing gives a more uniform look between weeds and turfgrass, reduces herbicide use, and helps stabilize soils. Mowing at proper heights (with properly maintained machinery) can also minimize the presence of weeds – anything less than one inch may destroy the turfgrass, allowing weeds to further propagate.

Controls

Manual control

Although manual control of weeds is slow and tedious, it does have its place in overall weed management. The key in manual removal is to understand the plant life cycle. Annual weeds need to be stopped before they go to seed. Mowing or clipping seed heads before seed dispersal may be an option for managing annual weeds. Perennial weeds need to be removed by the roots. Digging or pulling would be required for this type of management (an asparagus knife works well).

Biological control

For some weeds, there are biological controls. The Society for the Protection of New Hampshire Forests has recommendations on insects that can be released that feed on the target weed. Biological controls are often very effective at managing large weed infestations. These weeds typically wouldn't be in your turfgrass area, but they are frequently found adjacent to them. See the Resources section under "Weeds and Weed Control" for more information on biological control.

Chemical control

Herbicides are the most common tool used for weed control. They have an important place in weed control, but sometimes they are used in a "sloppy" fashion (applied at wrong time of the year, applied over entire site, applied with un-calibrated equipment). To protect the environment, weed control focus must be on less and smarter use of herbicides. This will allow us to protect our water but still meet turfgrass quality expectations. Smart use of herbicides includes:

- Identifying the type of weed and selecting the appropriate herbicide.
- Applying herbicide at the optimum time in the weed's lifecycle. See Weed Management diagram at the beginning of this section and the chart below.
- Applying herbicide in the proper quantities using calibrated equipment.
- Using spot treatments.
  - Apply herbicide to only the area of infestation.
  - Reduce or eliminate blanket treatments.
- Following Department of Agriculture advice on the proper use, handling, and storage of herbicides. See next section.
- Avoiding spraying herbicide in the root zone area around the bases of trees. Studies show long-term damage to tree health from this practice (Fraedrich, n.d.).
- Looking for opportunities to use less herbicide.

Lawn Weed Management Summary:
Selecting and Using Herbicides Based on Plant Life Cycles

Life Cycle: Annual
Weed Type: Broadleaf
Herbicide Category: selective, post-emergence
Optimal application timing: late spring through early summer when weed seedlings are still small but actively growing.

Common Examples: prostrate knotweed, annual chickweed, common ragweed, common mallow

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Life Cycle: Perennial
Weed Type: Broadleaf
Herbicide Category: selective, post-emergence
Optimal application timing: late summer to early fall when temperatures are cooler and usually more rainfall is occurring thereby causing plants to resume active growth; second best time would be early spring as active growth resumes during cooler temperatures.

Common Examples: common dandelion, white clover, perennial and mouse-ear chickweed, heal-all, plaintains, musk and bull thistle rosettes, Canada thistle

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Life Cycle: Annual
Weed Type: Grass
Herbicide Category: selective, pre-emergence
Optimal application timing: mid-spring as soil temperatures reach the mid fifties but before germination of weedy grass seeds has begun; usually early to mid-May.

Common Examples: smooth and large crabgrass, yellow, green and giant foxtail, barnyard grass

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Life Cycle: Perennial
Weed Type: Cool-season grasses
Herbicide Category: non-selective, post-emergence
Optimal application timing: best at cooler times of the year when weeds are actively growing; control can also be effective at other times when active growth is occurring. ***Use of non-selective products in a lawn will require overseeding or resodding in order to repair those areas killed by these products.***

Common Examples: creeping bentgrass, quackgrass, tall fescue, reed canary grass

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For more information on specific weeds and possible control strategies and chemical controls, call the UNH Cooperative Extension Info Line at 1-877-398-4769 or go to the UNH Cooperative Extension, Home and Garden Information Publication website, and click on the weeds link: http://extension.unh.edu/pubs/pubshg.htm#HG_Twy.

For information pertaining to rules and regulations governing herbicide and other types of pesticide applications in the State, contact the NH Division of Pesticide Control at (603) 271-3550 or visit the NH Department of Agriculture at http://agriculture.nh.gov/divisions/pesticide_control/index.htm.

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APPENDICES

Appendix A
Minnesota Acknowledgements

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Manual for Turfgrass Maintenance with Reduced Environmental Impacts

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Appendix B
Summation of Tips

Save time and money: Use the right amount of material at the right time, and use less material in the long run.

Expertise in turfgrass maintenance is a good reflection on you and your town or organization.

To protect our surface waters, use less chemicals, prevent erosion, and sweep up grass clippings and other vegetative debris from sidewalks, driveways, and other hard surfaces.

Do not direct the discharge of clippings from side delivery mowers onto the street. These can directly pollute surface waters when they flow into storm drains with surface runoff.

To protect the environment and get the most out of your fertilizer, use slow-release Nitrogen fertilizer.

Nitrogen is more of a problem pollutant for saltwater, while phosphorus is more of a problem pollutant for freshwater; however, excessive amounts of both can lead to problems in both salt- and freshwater systems.

Most New Hampshire soils are rich in phosphorus and do not require additional phosphorus applications to adequately support an established turfgrass stand. Always use a soil test to be sure – don't guess!

New Hampshire law stipulates a 25' fertilizer-free buffer around all water bodies. Outside this 25' buffer, fertilization is allowed, but make a point to sweep up excess fertilizer that is spilled or otherwise left on hard surfaces within 250'.

Infrequent, deeper waterings encourage deeper root growth, which is ideal during wetter months and when grass is new.

Know your turf grasses! Understanding which grasses grow best in certain conditions will allow for your turfgrass to remain healthy and, therefore, being better for the environment and water quality.

For the best growing results, follow the soil test guidelines, not the fertilizer bag guidelines.

If soil test indicates that P and/or K are adequate, use only N if available (e.g. urea, ammonium sulfate, corn gluten, etc).

You can save fertilizer by storing it over the winter in closed containers.

Never fertilize on frozen ground or before spring green up. It will green up our lakes, not our turfgrass.

If applying by the bag instructions instead of the Best Practices Matrix or soil test suggestions, you may be applying too much fertilizer.

Apply only what is recommended. Excess nutrients contaminate lakes, rivers, estuaries, and groundwater.

Ideal soil pH is between 5.5 and 7.0 on a scale of 1 (most acidic) to 13 (most alkaline). A soil test will identify your soils' pH level, and will make recommendations of lime treatment to reduce acidity levels if necessary.

Similarly to fertilizers, you can store herbicide over the winter to save on costs. Be sure to store in a safe, airtight container, in a dry environment.

Unirrigated sites cannot tolerate high traffic during hot, dry conditions. When possible reduce traffic to the area during hot, dry conditions.

Save our water by continually adjusting your irrigation system, depending on rain and soil moisture. Stay within Best Practices Matrix watering guidelines.

Add a rain or soil moisture sensor to your irrigation system-you'll use less water (the right amount) and save money. Neglected turfgrass areas can cause soils, with attached nutrients and pesticides, to erode and contaminate our waters.

Keep leaves and clippings off of paved surfaces. Take care, also, to wash mowers and other equipment inside or over vegetated areas so that soil, grass clippings, oil and greases are not washed into the storm drain.

Calibration is a great way to improve your operations, save money, and protect the water.

Some fine fescue mixes, often called "low-mow" or "no-mow," are excellent for low-use areas. They do not require weekly mowing.

Over-seeding is one of the best and most environmentally safe herbicides. Grass and weeds can't occupy the same spot. The best time to over-seed is late summer/early fall, or late winter/early spring. More grass, less toxins!

Taller turfgrass will be healthier and requires less water and fertilizer.

Weeds may be acceptable in difficult sites, such as boulevards. Use mowing to indicate the site is well maintained.

Spot-treatment uses less chemical. That's better for the environment and may save money.

If you know the name and type of weed you have, you can control it with the least amount of chemical and effort. Take time to identify your most troublesome weeds and determine which of the four main categories they belong.

Consider native grasses and wildflowers for sites where turfgrass does not grow well. Native species do not require any additional fertilizer or watering on your part!

Healthy, dense turfgrass is better for the environment than neglected turfgrass.

Appendix C
Using Turf Reflectance Meters to Guide Nitrogen Fertilization of Turf

Excerpts from research, recommendations, and presentations by: Karl Guillard and Thomas F. Morris, Department of Plant Science and Landscape Architecture, University of Connecticut.

Why Use a Turf Meter

Most soil tests for turf do not measure for nitrogen. If they do, they typically do not guide fertilizer rates. Determining whether turf may need nitrogen is typically done using visual assessments based on observations developed by experience. The turf color and density provide the best benchmarks for healthy turf. For example, a yellow color may indicate a lack of nitrogen. Although the human eye is good for separating differences in turf color that are far apart, it is more difficult to separate out small differences in color.

Turf color will reach peak green at some level of available nitrogen in the soil. Color will then remain constant no mater how much nitrogen is added. As a result, the greener the grass becomes, the probability of exceeding water quality standards and regulations is increased. Frequent measurements with a turf meter provide a correlation between the turf color and the optimum nitrogen in the soil. Using the Turf meter can prevent excess nitrogen being applied resulting in:

- ✓ Less chance of water quality concerns.
- ✓ Less chance of wasting fertilizer.
- ✓ Less chance of diseases and insects associated with overly succulent turf.

How to Measure Turf Color to Guide Nitrogen Fertilization with the *FieldScout TCM 500 NDVI Turf Color Meter*

1. Set up a strip of well fertilized turf that will be used as the reference strip at the site.
   - Measure off and mark a small turf plot of about 3 x 5 feet.
   - Fertilize the plot with nitrogen as you normally would about one to two weeks before collecting measurements. Do not fertilize if turf already appears optimum and collect and record measurements now.
2. Collect and record measurements from the reference strip on a dry day one to two weeks later. (See "How to use the Turf Meter" below)
3. Collect measurements from the remainder of the field/area, and compare it to the reference strip data.
4. If the rest of the field is with 95-100% of the reference values, it is likely there is no need to fertilize.
   a. If the data is less than 95% of the reference values, apply fertilizer according to percentage (percentages closer to 95% need less fertilizer than percentages further from 95%; i.e. at 70% may need some – 0.25 lbs per 1000 square feet; at 50% may need 0.50 lbs per 1000 square feet, etc.).
5. Continue to use the original numbers from your reference strip as a goal to guide your need for fertilizer during the growing season.
6. Documenting the data (by manually recording the readings or downloading the

Collecting turf meter measurements from fertilized reference strip

data from the Turf Meter to a computer) is helpful in determining how much nitrogen is needed based on percentage.

7. Adding nitrogen to above optimum levels (greater than 95% of the reference strip) can lead to nitrogen overloading, which increased the chance for nitrogen loss from the soil system (that will inadvertently wash into surface and ground water systems).
8. Until readily reliable tests measuring nitrogen are available, consider:
    a. Categorizing sites based on N response (Low, Medium, High) and fertilizing accordingly; e.g., a site that has a low response to N fertilization (no marked change in greenness or density) probably already has sufficient available soil N and no further supplemental N is required at this time. Whereas a site that has a high response to N (rapidly greens up and gets denser) may need higher rates of N until enough soil organic matter builds up to support mineralization rates that supply sufficient amounts of N to the turf before rates can be reduced,
    b. Using lower rates of nitrogen fertilization frequently (which is better than higher rates infrequently),
    c. Applying half the rate, then monitor for turf response,
    d. Using slow release or organic-based fertilizer,
    e. Using lower nitrogen-requiring species – fescues, etc,
    f. Earlier cutoff dates for fall fertilization – September 15 in northern NE,
    g. Reintroducing white clover (small leafed form – Dutch), which add nitrogen to the soil naturally.

Follow with expectations set by management, adapt the management techniques as necessary, and allow for the change to set in before reverting back to previous ways.

How to use the Turf Meter - *FieldScout Turf Color Meter TCM 500 NDVI*

Note: For more description on specifications and definitions in relation to this meter, please see the product manual. This document is designed to be used as a field guide.

1. Allow for the Turf Meter to adjust to turfgrass conditions before sampling. Take measurements only when the surface is dry; wet conditions may result in erroneous readings.
2. While adjusting the Turf Meter, make a note of any observations regarding turfgrass; i.e. patchiness, changes in activity/traffic, most recent rainfall, etc. It is best to compile meter data on turf that is more similar in density, species composition, and uniformity, than on turf that highly variable in those characteristics. It will be harder to develop an N management practice using the meter on turf that is not similar. Some amount of common sense will be needed in using the meter as a guide to N fertilization.
3. Turn on Turf Meter with "ON" button, and allow for "battery" and "logger % full" to display, then place Turf Meter on the sample site and press the green "READ" button.
    a. If an error occurs, "!!ERROR!!" will appear, with the error description below. The most common error at this stage of sampling is "Light Leakage". This means that the face of the meter was not pressed down hard enough on the turf canopy. Clear this from the display and try again by pressing the meter down on the turf surface more firmly and take another reading. If you continue to get the "Light Leakage" message, then move to another spot in the field/area since the ground surface may be highly uneven at that location.
4. The Turf Meter will display a number depending on the mode you have selected. There are three modes available with the Turf Meter:
    a. Percent reflectance – RED/IR, with a number between 0.0 and 99.9
    b. NDVI – with a number between 0.000-1.000

c. Grass index – with a number between 1.00 and 9.00

*Note: to change the mode, press the "MODE" button until desired mode displays.

5. Each mode has two numbers displayed – the first is the measurement for the current sample, the second is the running average. When the Turf Meter is turned off (either manually or after 10 minutes of no use), the running average resets.
6. Record either the first or average measurement on your site assessment form, which can be referenced later, when choosing maintenance techniques. (Note: remember to reset the average measurement if you plan on measuring turfgrass color on numerous sites)
7. To turn meter off, simply press "ON" again.

Additional tools related to the Turf Meter:

To attach the T-Handle:

1. Loosen the nuts on the screws (take care not to remove the nuts). Place the Turf Meter on a flat surface.
2. Make sure the red button on the T-Handle is facing forward, and position the T-Handle over the Meter's handle.
3. Push nuts through the holes in the Meter's handle, then slide handle forward. Tighten screws to lock T-Handle in place.
4. Insert the 3.5mm serial plug into the data port. Turn on Meter with on button, and use red button on T-Handle to take readings.

NOTE: If you have problems with the T-Handle staying attached you may want to purchase two small hose clamps and put those on instead; they hold the T-handle better to the box.

To connect to a GPS unit:

1. To use a GPS with the Meter, you must have the CD software installed, with the logger function enabled (see Turf Meter manual for further instruction on installing software).
2. Turn on a plug GPS into the Turf Meter before turning it on. Once turned on, the logger will search for a GPS signal for every reading. If no GPS is found when first turned on, the meter will not search for a connection, and the message "No GPS Found" will display.

*NOTE: If you plan on using both a GPS unit and the T-Handle, you must use the y-splitter cable. Plug the y-splitter into the data port first. The T-Handle is plugged into one connector, and the GPS unit is connected into the other.

Appendix D
Pilot Community Tracking Checklist

Town: _____
Use this form to track dates and hours.
Use the Site Assessment form for specific data and management information.

Turf and Reflectance Meter Information:

- *Fertilize 5x5' plot as reference plot:*
  Date fertilized (if applicable): _____

Fertilizer used throughout growing season:
*April:*_____ *July:*_____ *August:*_____

Draft Manual Information:
Please make note of:
What practices you are using on your fields?

1) What recommendations from the manual you are using?
2) How well are the recommendations working for you?
3) Did using the turf meter result in using less fertilizer in the pilot fields? How much less?

	April	*July (optional)*	*September*
What practices are you using on your fields?			
What recommendations from the manual are you using?			
How do you think the practices working?			
Did using the turf meter result in using less fertilizer in the pilot fields? How much less?			

Hours spent on duties outlined above:

Date	Time Start	Time End	Explanation of tasks

Appendix E
Changing Lawn Care Behavior to Reduce Nutrient Loss

Every spring, people around New Hampshire and New England are eager to see green in their lawns and public places – except in their local streams, rivers, lakes, and estuaries. Excess nutrients, like nitrogen and phosphorus, can turn our waters green, which can kill off species by blocking out oxygen, sunlight, and other naturally occurring nutrients. Fresh waters are considered more sensitive to phosphorus (P) levels and estuarine and marine waters more sensitive to nitrogen (N) levels.

Many New Hampshire communities are becoming more concerned about increasing nutrient levels in local waterbodies because of the effects excess nutrients can ultimately have on water quality, public health and property value. Excess nutrients can come from wastewater effluent, faulty septic systems, the atmosphere and agricultural waste, yard and pet waste, as well as from runoff containing residential and commercial fertilizers.

A Current Project:
Communities throughout New England can point to beloved waterbodies that are under pressure, and a recent USDA grant funded project is trying to tackle one potential contributor to the excess nutrient problem – how much lawn fertilizer is too much and how decisions people make about their lawn care practices affect water quality.

The cross-disciplinary project includes a social science component and a plant science component. The project integrates research, education of college and graduate students and extension to move the project information into the hands of homeowners, garden centers, Master Gardeners, agencies, municipalities, and environmental groups who can use it. The extension component is being carried out by Cooperative Extension specialists in Connecticut, Maine, New Hampshire, Rhode Island and Vermont. An advisory group that includes agricultural extension educators, state environmental agency staff and the owner of a garden center has contributed greatly to the design and execution of the project.

The ultimate goal of the project is to reduce nitrogen losses from lawns into local waterbodies. Research indicates that trees and shrubs in riparian zones offer some of the best protection for water quality; however, New Hampshire has experienced a significant conversion of forests and fields into residential development over the last few decades resulting in increased opportunities for nutrient runoff.

First Line of Defense: Promoting Healthy Soils and Lawns:
Recommendations For Water-Quality Friendly Lawn Care Practices

- Mow high (2.5 – 3 inches) – this encourages longer, stronger turf grass roots and healthier turf that can survive stress. For best results, cut no more than 1/3 of the blade at any mowing.
- Leave the clippings after mowing. They provide a source of slow release nutrients and count as one application of nitrogen fertilizer per year.
- When seeding, use grass varieties that require less maintenance. In northern New England choose seed mixes with higher percentages of turf-type tall fescues, compact-type tall fescues and/or fine fescues and smaller percentages of Kentucky blue grass and/or perennial ryegrass. Overseeding may solve what fertilizer cannot.

- Incorporate white clover into the lawn. It naturally fixes nitrogen in the soil. If someone in the household is allergic to bee stings, use another type of low growing legume or disregard this recommendation.
- One inch of rain or water per week is typically enough for turf. Watering in the morning is best for preventing fungus or excessive evaporation.
- Conduct a soil test if the lawn condition is unacceptable. The soil test can provide information about what the soil does and does not need. Sometimes adjustments to pH or soil organic matter are what are needed.
- Manage expectations. Grass requires abundant sun and some additional maintenance. Consider limiting lawn area to sunny locations where lawn will actually be used for playing, picnicking, hanging laundry and other activities. Make health and safety of children, pets and the environment a top priority.

If Fertilization is Decided Upon: Safer Practices – Water Quality Friendly Guidelines for When, What, Where, How and How Much Fertilizer to Apply If Needed

- In northern New England, apply no earlier than spring green up and no later than mid-September. Applying fertilizer when the soil temperature is too low increases the likelihood of nutrient losses off the lawn.
- If a soil test indicates that phosphorus (P) and potassium (K) levels are adequate, only nitrogen (N) fertilizer may be necessary. In these cases, fertilizers containing only N are preferable to blended N-P-K fertilizer. If only blended products are available, choose the one with the lowest P.
- Slow release formulations (those containing >50% water insoluble nitrogen) are generally preferable to soluble, fast release formulations.
- Fertilizers should not be applied near streams, rivers, lakes, estuaries, bays, coastal areas, vernal pools, wetlands or drainage areas, etc. Leave at least a 20 foot setback away from water or as stipulated by local or state regulations. Local or state regulations may also restrict other aspects of fertilizer use.
- Calculate the amount of fertilizer needed based on the size of the area, the desired rate of application and the proportion of N in the formulation listed on the bag. Follow the steps on this factsheet: http://extension.unh.edu/resources/files/Resource000513_Rep535.pdf or use the calculator at this web address: http://www.cag.uconn.edu/ces/sustainability/fertcalc.html
- Calibrate the spreader prior to using it. To view a video clip on calibrating a spreader, check the UNH Cooperative Extension website under Agriculture.
- Applying more nutrient than the grass can use contributes to nutrient runoff and water pollution! Use only the portion of the bag that is needed and store or share the remainder.

Adapted from "Report on Changing Lawn Care Behavior to Reduce Nutrient Losses in New England's Urbanizing Watersheds", written by Julia Peterson.

Appendix F
Purchasing Seeds and Understanding Seed Labels

Purchasing the highest quality seed possible is always a good investment. Improper cultural practices will waste the money invested in purchasing high quality seed. However, poor quality seed will almost never result in a well-established lawn no matter how good the cultural practices. Determining what high quality seed is can be difficult for most people. Purchasing high quality seed can be easier if you understand a few basic terms on the grass seed label. All labels must provide information about the grass seed purity, its germination potential, crop seeds present, weed seeds present, noxious weeds present, and inert components in the package.

Example seed label
(Company and variety names are fictitious)

TURF-GROW SEED COMPANY, TURFTOWN, OREGON
Lot No: 7890-8

Test Date: (month/year)

Pure Seed	Variety	Germination	
44%	Arctic Creeping Red Fescue		85%
31%	Blue Ribbon Kentucky Bluegrass	80%	
9%	Wilson Chewings Fescue	85%	
12%	Gopher Perennial Ryegrass		90%
1.56%	Crop		
2.11%	Inert Matter		
0.33%	Weeds		

Noxious Weed Seed: 25 Canadian Thistle Seeds Per Pound

Purity is the percent by weight of pure seed, crop, weed, and inert ingredients in the package. These percentages added together should total 100 percent. Purity is concerned only with quantity, not quality. That is, not all seeds present in the package are capable of growing. To determine the seed that will actually grow or what is known as *pure live seed*, the percentage purity should be multiplied by the germination percentage. For example, 90 percent Kentucky bluegrass (purity) multiplied by 85 percent germination conditions. It should be apparent that you should always seek to purchase the grass seed with the highest purity and germination percentage possible.

Germination is the percent of pure seed that will germinate and grow in an ideal laboratory environment during a prescribed length of time. Since field conditions rarely duplicate these laboratory conditions, it is especially important to purchase seed with the highest germination percentage possible. As noted above, this is the percentage used to determine pure live seed.

Crop is the percent by weight of seeds normally considered to be grown as an agricultural crop such as grain. This can include other types of grasses that may be undesirable in a lawn. This percentage should be as close to zero as possible.

Weeds refer to the percent by weight of all seeds in the package that are not otherwise listed in pure seed or crop. It is not required to identify these weeds or how many there are since this is on a percent by weight basis. For example, one or two large seeds of a weed species would pose no particular threat. This percentage should always be as low as possible.

Noxious weeds are listed as the number per pound, not the percentage per pound. Noxious weeds are weedy plants considered by individual states to be very difficult to control and that could pose hazards to both human

and livestock. While this is often more of a problem in farm crop seed, one should always buy grass seed without the contamination of any noxious weeds.

Inert is the percent of material contained in the package that will not grow under any condition. Broken and damaged seeds, chaff, and empty seed hulls are some of the more common inert material included. Obviously, this percentage should be as low as possible.

Considering seed count vs. seed weight

The Federal Seed Act requires that grass seed be listed on the label by weight and that it be separated into two broad categories: fine-textured grasses and coarse-textured grasses. However many of the grasses vary significantly in their respective seed sizes and consequently vary significantly in the number of seeds per pound. A more accurate description of the grass seed contents contained in a package would be to list their percentage by seed count rather than percentage by weight. For example, large seeds (such as those of perennial ryegrass) are quite heavy and take only about 225,000 seed to make one pound. On the other hand, Kentucky bluegrass requires from 1 to 2 million seeds, depending on variety, to make a pound.

Given the above example, a 50 percent perennial ryegrass: 50 percent Kentucky bluegrass mix by weight actually contains only about 112,500 seeds of perennial ryegrass per pound of mix. The number of Kentucky bluegrass seeds present in this mix would be about 500,000 to 1 million. Therefore this sample mixture contains about 11 to 23 percent perennial ryegrass and 77 to 89 percent Kentucky bluegrass. Using this example, one may need to add a certain amount of one type of grass or another based on seed count to create the best mix for a particular site condition. For example, adding some additional pure creeping red fescue seed to an off-the-shelf seed mixture for shady areas will increase the number of seeds of the more shade tolerant creeping red fescue. This should provide greater potential for establishing a lawn in the more shady parts of the landscape.

University of Minnesota Extension Service Master Gardener Core Course textbook – Lawn Care section. Bob Mugaas, Extension Educator, University of Minnesota Extension. 2002

Appendix G
Guidelines for Equipment Storage/Idle Equipment

- Fuel should be emptied when possible and carbs drained, or run until it dies.
- If machine has a tank that can have the fuel shut off, cut fuel, drain carb and FILL the tank to the brim. This will prevent condensation from forming in the tank. Try to run empty or drain whenever it is feasible. Example: you have a 10 gallon tank with 8 gallons in it, fill it. If it has 1 gallon, drain it. Let common sense dictate your decision.
- Oil changed and all fittings greased. Check and fill all fluids.
- All air filters or dust screens cleaned.
- If tool requires sharpening, do it.
- Tires properly filled. Note and report deficient conditions.
- Check belts for wear and cracks, note and report deficient belts.
- Check all lights and wiring. Replace bulbs if needed.
- Machine is to be thoroughly cleaned, engine underbody completely cleaned. Waxed whenever possible.
- Battery water level checked and battery charged, either by operating the machine or with a charger.
- Machines that are stored in cold storage should have the batteries charged and then disconnected. See mechanic for details on the particular piece of equipment.
- Tag the piece of equipment with the date it was stored.
- Note any deficiencies that need to be addressed. Put that on the stored equipment tag along with date.

This process applies to ALL equipment. All equipment should have this process completed within 30 days of end of use.

Created by Jim Weber at University of Minnesota Landcare Department

Appendix H
Example - Daily Maintenance Checklist

Equipment_____Unit Number_____

Check Items:	MON	TUES	WED	THURS	FRI
DATE:					
OPERATOR:					
1. CHECK ENGINE OIL					
2. CHECK TIRES & AXLES					
3. CHECK ALL BOLTS & FASTENERS					
4. CHECK TINE BOLTS & MECHANISM FOR WEAR OR DAMAGE					
5. CHECK STARTER ROPE FOR WEAR					
6. CHECK CHAINS AND LUBRICATE BIO DAILY					
7. CHECK BELTS RACKS FOR CRACKS AND WEAR					
8.LUBRICATE EIGHT GREASE FITTINGS DAILY					
9. CLEAN AIR FILTER					
10. CHANGE ENGINE OIL MONTHLY (10W-30) please date last oil change					

VERY IMPORTANT

* If there is any doubt as to the condition and/or safe operation of the equipment specified above, notify your gardener immediately so he/she can notify the proper repair technician.

IF THERE ARE ANY KNOWN DEFICIENCIES, PLEASE NOTE BELOW.

Created by Jim Weber at University of Minnesota Landcare

Appendix I
Site Assessment

Date: _____ Assessor: _____

Site name: _____

Address: _____

Age of turf _____ (years) Turf size _____ (sq.ft.)
Dogs: ☐ Yes ☐ No
Children: ☐ Yes ☐ No
Traffic Volume: ☐ Minimal ☐ Average ☐ High

Customer/Town Expectations & Maintenance Practices

Lawn Condition: ☐ Minimal ☐ Average ☐ High
Clippings bagged: ☐ Yes ☐ No
Organics only: ☐ Yes ☐ No
Fertilizer: ☐ Yes Ratio_____ ☐ No
Herbicides: ☐ Whole yard ☐ No ☐ Spot treat (add sketch)
Herbicide needed: ☐ Pre-emergent ☐ Broadleaf ☐ Non-selective ☐ None
Pesticides: ☐ Whole yard ☐ No ☐ Spot treat (add sketch)
Irrigation: ☐ Yes ☐ No
Calibrated: ☐ Yes, Date_____ ☐ No
Water reaching hard surfaces: ☐ Yes ☐ No
Rain sensor: ☐ Yes ☐ No
Operating properly: ☐ Yes ☐ No
Estimated water output: _____
Watering frequency: _____

Turf Condition

Turf Meter

Turf Meter average: _____ *Number of Readings (N):* _____

Take photographs. It may be helpful for next year to match a visual to a specific turf meter reading.

Grass

Major turf grass(es): ☐ Kentucky bluegrass ☐ ryegrass ☐ fine fescue

Condition of grass: ☐ blade damage ☐ good ☐_____

Thatch depth: _____" Rooting depth: _____"

Lawn density: ☐ thin ☐ average ☐ high

Soil sample(s) collected: ☐ Yes ☐ No
If Yes:

Soil texture: ☐ *Coarse (sand, loamy sand, sandy loam)*
☐ *Medium (loam, silt loam)* ☐ *Fine (clay loam, silty clay loam, silty clay and clay)*

Compaction test: ☐*not compacted* ☐ *somewhat compacted* ☐ *compacted*

Weed severity: ☐ many ☐ some ☐ few

Weed/Disease Types:_____
_____

Sun exposure (%): ☐ Full-sun_____
☐ Part-sun_____
☐ Shade _____

Other observations
Erosion problems_____
Intensity of Use_____
Wet Areas_____
Overall Topography_____

Sketch/Notes:

Recommendations (☐ add additional page):

Appendix J
Additional Minnesota Resources

Environmental Resources:
Minnesota Department of Natural Resources Lake Finder http://www.dnr.state.mn.us/lakefind/index.html

Minnesota Pollution Control Agency http://www.pca.state.mn.us/
http://www.pca.state.mn.us/water/tmdl/index.html (Impaired Waters)

Mississippi Watershed Management Organization http://www.mwmo.org/

Equipment (Incomplete List of Suppliers):
Find a local vendor or contractor from the sites below.
Maintenance Equipment
www.toro.com
www.exmark.com
www.deere.com

Irrigation Systems
www.hunterindustries.com
http://www.toro.com/watermgmt/index.html
http://store.rainbird.com/

Soil Probes, Soil Thermometers and Anemometers
Forestry Suppliers, Inc.
205 West Rankin Street
Jackson, MS 39201
www.forestry-suppliers.com

Ben Meadows
1-800-241-6401
www.benmeadows.com

Fertilizers and Fertilizing:
Fertilizer research – Best time to fertilize:
www.extension.umn.edu/distribution/horticulture/dg3338.html

How to Dispose of Lawn Fertilizer Containing Phosphorus
http://www.mda.state.mn.us/chemicals/fertilizers/options-for-leftover-lawn-fert.aspx

Irrigation
EPA Water Sense Program- professional certification for irrigation designers, contractors, and auditors.
www.epa.gov/watersense/services/cert_programs.html.

Minnesota Department of Agriculture:
625 Robert Street North, St. Paul, Minnesota 55155-2538
651-201-6000 or 1-800-967-2474 http://www.mda.state.mn.us

Minnesota Department of Agriculture Fact Sheets:

To view the following factsheets, go to:
http://www.mda.state.mn.us/en/licensing/licensetypes/pesticideapplicator.aspx

- Pesticide Applicator Incident Response Plan Guide
- Pesticide Applicator Initial License and Renewal Requirements
- Pesticide Applicator License Categories
- Pesticide Applicator License Changes & Fees
- Pesticide Applicator License Types
- Pesticide Applicator Recertification Requirements
- Steps to Successfully Completing a Pesticide Certification Exam
- Pesticide Application Record – Category E
- Pesticide Containers: Management & Disposal
- Pesticide and Fertilizer Storage: Small Package Requirements
- Management & Disposal of Pesticide Containers

Minnesota Department of Agriculture staff is available to receive reports 24 hours a day, 7 days a week. MDA uses the Department of Public Safety's duty officer system. Call *651-649-5451* (metro) or *800-422-0798* (non-metro) day or night. The duty officer will relay your message to an MDA staff person on duty who will call you back promptly with instructions.

Managing Pesticides, Waste Pesticides & Empty Pesticide Containers
http://www.mda.state.mn.us/protecting/bmps/waste.aspx

Minnesota Pollution Control Agency (MPCA)
http://www.pca.state.mn.us/programs/summermaintenance.html
Minnesota State Statutes https://www.revisor.mn.gov/statutes/

Miscellaneous Resources:
Garden Arithmetic Calculators http://www.math.umn.edu/~white/personal/arithmetic.html

Heavy Metals in Fertilizer http://www.mda.state.mn.us/chemicals/fertilizers/heavymetals.aspx
Paul McNelly, Minnesota Department of Agriculture, (651) 201-6560

Tree Owner's Manual for the Northeastern and Midwestern United States is available online in PDF format.
http://www.ctpa.org/TreeOwnersManual.pdf

Aerial photo measurement tool (fee required)
www.goilawn.com

Organic Lawn Care: www.safelawns.org
The Organic Lawn Care Manual by Paul Tukey
The Chemical Free Lawn by Warren Schultz

Phosphorus-Free Lawn Care:
Use Phosphorus-Free Lawn Fertilizer to Protect Minnesota Lakes and Rivers Handout

http://156.98.19.245/download/phosphorus.pdf

Phosphorus in Lawns, Landscapes and Lakes
http://www.mda.state.mn.us/news/publications/chemfert/reports/phosphorusguide.pdf

Seeding:
Lawn Renovation (2010) by R.J. Mugaas and B.W. Pedersen
www.extension.umn.edu/distribution/horticulture/dg3914.html

Soil Temperatures:
http://climate.umn.edu/cawap/soilpan/soilpan.asp

Soil Testing Laboratories:
http://soiltest.cfans.umn.edu
http://www2.mda.state.mn.us/webapp/lis/soillabs.jsp

Soils and Soil Testing Resources:
University of Minnesota Extension
http://www.extension.umn.edu/info-u/plants/BG468.html

Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape Plants
http://www.extension.umn.edu/distribution/horticulture/DG1731.html

Web Soil Survey
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Training Resources – Turfgrass Maintenance with Reduced Environmental Impacts:
Fortin Consulting – Additional training
http://www.fortinconsulting.com/ourwork.html

Minnesota Pollution Control Agency (MPCA)- turfgrass manual, best practices matrix, certified individuals, schedule of classes.
http://www.pca.state.mn.us/programs/summermaintenance.html

Training Resources – Other training courses:
Minnesota Circuit Training and Assistance Program
http://www.mnltap.umn.edu/About/Programs/CTAP

Minnesota Erosion Control Association
http://www.mnerosion.org

Minnesota Pollution Control Agency (MPCA) - winter maintenance training
http://www.pca.state.mn.us/programs/roadsalt.html

Mississippi Watershed Management Organization
http://www.mwmo.org

University of Minnesota Extension

http://www.extension.umn.edu

Weed and plant identification:
Grasses and Broadleaves-photos and drawings
http://www.extension.umn.edu/distribution/cropsystems/DC0776.html
http://128.104.239.6/bioipm/BioIPM%20Book/9_AppendixA3.pdf
http://www.extension.umn.edu/distribution/cropsystems/DC2928.pdf
http://www.lawn-care-academy.com/weed-identification-perennial-2.html
http://www.aragriculture.org/horticulture/ornamentals/weed_id/default.htm

Minnesota Invasive non-native terrestrial plants
http://www.comm.media.state.mn.us/bookstore (MNDNR Guidebook)
http://www.dnr.state.mn.us/invasives/terrestrialplants/index.html

Noxious Weeds
http://plants.usda.gov/java/noxious?rptType=State&statefips=27

University of Minnesota Gardening information- diagnostics for weeds, insects and turfgrass
http://www.extension.umn.edu/gardeninfo/

Weed Seedling Photos
http://www.extension.umn.edu/distribution/cropsystems/DC7376.html

Weeds and Weed Control:
Biological control
Monika Chandler, Minnesota Department of Agriculture
Monika.Chandler@state.mn.us(651) 201-6537

National Pesticide Information Center http://www.npic.orst.edu/

Pesticide Application Safety Signs
Example sources: www.gemplers.com
www.mysafetysign.com
www.grainger.com

Reporting Pesticide Misuse in Minnesota
http://www.mda.state.mn.us/chemicals/pesticides/complaints.aspx

Weed Control in Lawns and Other Turf – University of Minnesota
http://www.extension.umn.edu/distribution/horticulture/DG1137.html

Appendix K
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